IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Gopalakrishnan	
U.S. Patent No.:	10,595,731	Attorney Docket No.: 50095-0033IP1
Issue Date:	March 24, 2020	
Appl. Serial No.:	16/588,201	
Filing Date:	September 30, 2019	
Title:	METHODS AND SYSTEMS FOR ARRHYTHMIA TRACKING AND SCORING	

DECLARATION OF DR. BERNARD R. CHAITMAN

APPLE 1003

Table of Contents

I, Dr. Bernard R. Chaitman, of St. Louis, Missouri, declare that:

I. ASSIGNMENT

1. I have been retained on behalf of Apple Inc. ("Apple" or "Petitioner") to offer technical opinions related to U.S. Patent No. 10,595,731 ("The '731 patent") (APPLE-1001). I understand that Apple is requesting that the Patent Trial and Appeal Board ("PTAB" or "Board") to institute an *inter partes* review ("IPR") proceeding of the '731 patent.

2. I have been asked to provide my independent analysis of the '731 patent in light of the prior art publications cited in this declaration.

3. I am not and never have been, an employee of Apple. I received no compensation for this declaration beyond my normal hourly compensation based on my time actually spent analyzing the '731 patent, the prior art publications cited below, and issues related thereto, and I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the '731 patent

II. QUALIFICATIONS

4. I am over the age of 18 and am competent to write this declaration. I have personal knowledge, or have developed knowledge of these technologies based upon education, training, or experience, of the matters set forth herein.

5. I am an Emeritus Professor of Medicine, and Director of Cardiovascular Research at St Louis University School of Medicine. I am also a

Board-Certified Cardiologist and have practiced Internal Medicine and Cardiovascular Disease for four decades. I am currently licensed in the State of Missouri and Florida. I also serve as the Chair for Clinical Event Committees and Data and Safety Monitoring Boards for numerous clinical trials sponsored by National Heart Lung and Blood Institute (NHLBI) and industry. I am currently a member of the Editorial Board of nine journals that include Circulation, Journal of the American College of Cardiology, and the European Heart Journal. I also founded and am the Medical Director of St Louis University Core ECG Laboratory that provides ECG analysis for numerous NHLBI and industry sponsored clinical trials that test various treatment strategies.

6. I received a Bachelor of Science degree in 1965 and a medical degree 1969, both from McGill University in Montreal, Canada. I completed my Internal Medicine training at McGill University and Royal Victoria Hospital in 1972. I then completed post-graduate training in Cardiovascular Diseases at the University of Oregon (from 1972-1974) and University of Montreal (from 1974-1975).

7. I have a long and distinguished career in academic medicine and have published more than 400 peer-reviewed papers and more than 600 abstracts, book chapters, and short communications. My areas of expertise in Cardiovascular Medicine include rest and exercise ECG analysis, diagnostic noninvasive testing, large scale multinational clinical trials testing different treatment strategies, and

drug development. I have received funding from the National Heart Lung and Blood Institute (NHLBI) for more than 3 decades and also funding by the Department of Defense. My experience is recognized internationally and I have lectured abroad and published frequently with cardiologists in Europe.

8. I have served as a consultant to the Food and Drug Administration on ECG related issues, and the use of the rest and exercise ECG as a diagnostic instrument. I also served as a committee member for the American Heart Association, American College of Cardiology, and the European Society of Cardiology in matters related to ECG analysis and the use of ECG analysis as a diagnostic and prognostic tool. I served on grant review committees for the NHLBI, the Veterans Administration Review Board, and the American Heart Association.

III. SUMMARY OF CONCLUSIONS FORMED

9. This Declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions:

- **Ground 1:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 1, 7, 12, 13, 16, 17, 23-26 and 30 of the ’731 patent are rendered obvious by Shmueli.
- **Ground 2**: Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 1, 2, 4, 7, 12-

14, 16-18, 20, 23-26 and 30 of the ’731 patent are rendered obvious by Shmueli in view of Osorio.

- **Ground 3:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 13, 5, 6, 19, 21 and 22 of the ’731 patent are rendered obvious by Shmueli in view of Osorio and Li 2012.
- **Ground 4:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 8-11 and 27-29 of the ’731 patent are rendered obvious by Shmueli in view of Osorio and Kleiger 2005.
- **Ground 5:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claim 15 of the ’731 patent is rendered obvious by Shmueli in view of Osorio and Chan.

IV. BACKGROUND KNOWLEDGE ONE OF SKILL IN THE ART WOULD HAVE HAD PRIOR TO THE PRIORITY DATE OF THE ’731 PATENT

10. I have been informed that a person of ordinary skill in the art is a hypothetical person who is presumed to have the skill and experience of an ordinary worker in the field at the time of the alleged invention. Based on my knowledge and experience in the field and my review of the ’731 patent and file history, I believe that a person of ordinary skill in the art in this matter would have

had at least a combination of Bachelor's Degree (or a similar Master's Degree, or higher degree) in an academic area emphasizing health science, or a related field, and two or more years of work experience with cardiac monitoring technologies (e.g., as a cardiologist). Additional education or industry experience may compensate for a deficit in one of the other aspects of the requirements stated above.

11. My analysis and conclusions set forth in this declaration are based on the perspective of a person of ordinary skill in the art having this level of knowledge and skill as of the date of the alleged invention of the '731 patent ("POSITA"). Based on instruction from Counsel, I have applied March 14, 2014 ("Critical Date"), as the date of the alleged invention of the '731 patent. However, my analysis of the prior art and the conclusions I have formed as set forth herein would also apply even if the date of the alleged invention as claimed was December 12, 2013 ("earliest possible effective filing date").

12. Based on my experiences, I have a good understanding of the capabilities of a POSITA. Indeed, I have taught, mentored, advised, and collaborated closely with many such individuals over the course of my career.

V. LEGAL PRINCIPLES

13. I am not a lawyer and I will not provide any legal opinions in this IPR. Although I am not a lawyer, I have been advised that certain legal standards are to

be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.

A. Claim construction

14. I understand that claim terms are generally given their plain and ordinary meaning in light of the patent's specification and file history as understood by a person of ordinary skill in the art at the time of the purported invention. In that regard, I understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by a POSITA. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination before the Patent Office. I also understand that the words of the claims should be interpreted as they would have been interpreted by a POSITA at the time of the invention was made (not today).

B. Priority

15. I understand that a continuation application is a later-filed application that has the same disclosure (specification and figures) as an earlier filed application to which the later-filed application claims priority. A continuation is generally entitled to the same priority date as the later-filed application to which it claims priority.

C. Anticipation

16. I understand that a patent claim is invalid as anticipated if each and

every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. I also understand that, to anticipate, the reference must teach all of the limitations arranged or combined in the same way as recited in the claim. I do not rely on anticipation in this declaration.

17. With respect to inherency, I understand that the fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. Instead, the inherent characteristic must necessarily flow from the teaching of the prior art.

D. Obviousness

18. I understand that a patent claim is invalid if the claimed invention would have been obvious to a person of ordinary skill in the field at the time of the purported invention, which is often considered the time the application was filed. Thus, even if all of the claim limitations are not found in a single prior art reference that anticipates the claim, the claim can still be invalid.

19. To obtain a patent, a claimed invention must have, as of the priority date, been nonobvious in view of the prior art in the field. I understand that an invention is obvious when the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art.

20. I understand that, to prove that prior art or a combination of prior art renders a patent obvious it is necessary to: (1) identify the particular references that, singly or in combination, make the patent obvious; (2) specifically identify which elements of the patent claim appear in each of the asserted references; and (3) explain a motivation, teaching, need, market pressure or other legitimate reason that would have inspired a person of ordinary skill in the art to combine prior art references to solve a problem.

21. I also understand that certain objective indicia can be important evidence regarding whether a patent is obvious or nonobvious. Such indicia include:

- Commercial success of products covered by the patent claims;
- A long-felt need for the invention;
- Failed attempts by others to make the invention;
- Copying of the invention by others in the field;
- Unexpected results achieved by the invention as compared to the closest prior art;
- Praise of the invention by the infringer or others in the field;
- The taking of licenses under the patent by others;
- Expressions of surprise by experts and those skilled in the art at the making of the invention; and

- The patentee proceeded contrary to the accepted wisdom of the prior art.

22. To the extent these factors have been brought to my attention, if at all, I have taken them into consideration in rendering my opinions and conclusions.

VI. MATERIALS CONSIDERED

23. My analysis and conclusions set forth in this declaration are based on my educational background and experiences in the field (see Section IV). Based on my above-described experience, I believe that I am considered to be an expert in the field. Also, based on my experiences, I understand and know of the capabilities of persons of ordinary skill in the field during the early 1990s–2010s, and I taught, participated in organizations, and worked closely with many such persons in the field during that time frame.

24. As part of my independent analysis for this declaration, I have considered the following: the background knowledge/technologies that were commonly known to persons of ordinary skill in this art during the time before the earliest claimed priority date for the ’731 patent; my own knowledge and experiences gained from my work experience in the field of the ’731 patent and related disciplines; and my experience in working with others involved in this field and related disciplines.

25. In addition, I have analyzed the following publications and materials:

- U.S. Pat. No. 10,595,731 to Gopalakrishnan (“the ’731 patent”) (APPLE-

1001)

- Excerpts from the Prosecution History of the ’731 patent (“the Prosecution History”) (APPLE-1002)
- PCT Patent Publication WO2012/140559 (“Shmueli”) (APPLE-1004)
- U.S. Patent Publication 2014/0275840 (“Osorio”) (APPLE-1005)
- Li Q, Clifford GD, “Signal quality and data fusion for false alarm reduction in the intensive care unit,” J Electrocardiol. 2012 Nov-Dec; 45(6):596-603 (“Li 2012”) (APPLE-1006)
- U.S. Patent Publication 2008/0004904 (“Tran”) (APPLE-1007)
- U.S. Patent Publication 2014/0107493 (“Yuen”) (APPLE-1008)
- U.S. Patent Publication 2015/0119725 (“Martin”) (APPLE-1009)
- U.S. Provisional Application No. 61/794,540 (“Osorio Provisional”) (APPLE-1010)
- Lee J, Reyes BA, McManus DD, Mathias O, Chon KH. Atrial fibrillation detection using a smart phone. Annu Int Conf IEEE Eng Med Biol Soc. 2012; 2012:1177-800 (“Lee 2013”) (APPLE-1011)
- Tsipouras MG, Fotiadis DI. Automatic arrhythmia detection based on time and time-frequency analysis of heart rate variability. Comput Methods Programs Biomed. 2004 May; 74(2):95-108 (“Tsipouras 2004”) (APPLE-1012)

- Lu S, Zhao H, Ju K, Shin K, Lee M, Shelley K, Chon KH. Can photoplethysmography variability serve as an alternative approach to obtain heart rate variability information? J Clin Monit Comput. 2008 Feb; 22(1):23-9 ("Lu 2008") (APPLE-1013)
- Selvaraj N, Jaryal A, Santhosh J, Deepak KK, Anand S. Assessment of heart rate variability derived from finger-tip photoplethysmography as compared to electrocardiography. J Med Eng Technol. 2008 Nov-Dec; 32(6):479-84 ("Selvaraj 2008") (APPLE-1014)
- Lu G, Yang F, Taylor JA, Stein JF. A comparison of photoplethysmography and ECG recording to analyse heart rate variability in healthy subjects. J Med Eng Technol. 2009; 33(8):634-41 ("Lu 2009") (APPLE-1015)
- Suzuki T, Kameyama K, Tamura T. Development of the irregular pulse detection method in daily life using wearable photoplethysmographic sensor. Annu Int Conf IEEE Eng Med Biol Soc. 2009; 2009:6080-3 ("Suzuki 2009") (APPLE-1016)
- Reed MJ, Robertson CE, Addison PS. Heart rate variability measurements and the prediction of ventricular arrhythmias. QJM. 2005 Feb; 98(2):87-95 ("Reed 2005") (APPLE-1017)
- Schäfer A, Vagedes J. How accurate is pulse rate variability as an estimate of heart rate variability? A review on studies comparing

photoplethysmographic technology with an electrocardiogram. Int J Cardiol. 2013 Jun 5; 166(1):15-29 ("Schafer 2013") (APPLE-1018)

- K. Douglas Wilkinson, "The Clinical Use of the Sphygmomanometer," The British Medical Journal, 1189-90 (Dec. 27, 1924) ("Wilkinson") (APPLE-1019)
- U.S. Pat. No. 6,095,984 ("Amano") (APPLE-1020)
- B.K. Bootsma et. al, "Analysis of R-R intervals with atrial fibrillation at rest and during exercise." Circulation 1970; 41:783-794 (APPLE-1021)
- Frits L. Meijler and Fred H. M. Wittkampf, "Role of the Atrioventricular Node in Atrial Fibrillation" Atrial Fibrillation: Mechanisms and Management, 2nd ed. 1997 ("Meijler") (APPLE-1022)
- Heart Diseases _ Definition of Heart Diseases by Merriam-Webster (APPLE-1023)
- Rajendra Acharya U, Paul Joseph K, Kannathal N, Lim CM, Suri JS. Heart rate variability: a review. Med Biol Eng Comput. 2006 Dec; 44(12):1031-51 ("Acharya 2006") (APPLE-1024)
- Saime Akdemir Akar, Sadık Kara, Fatma Latifoğlu, Vedat Bilgiç. Spectral analysis of photoplethysmographic signals: The importance of preprocessing. Biomedical Signal Processing and Control, 2013; 8(1):16-22 (Akar 2013) (APPLE-1025)

- U.S. Provisional Application No. 61/915,113 (APPLE-1026)
- U.S. Provisional Application No. 61/953,616 (APPLE-1027)
- U.S. Provisional Application No. 61/969,019 (APPLE-1028)
- U.S. Provisional Application No. 61/970,551 (APPLE-1029)
- U.S. Provisional Application No. 62/014516 (APPLE-1030)
- U.S. Patent Publication No. 2012/0203491 ("Sun") (APPLE-1031)
- U.S. Patent No. 9,808,206 ("Zhao") (APPLE-1032)
- Kleiger RE, Stein PK, Bigger JT Jr. Heart rate variability: measurement and clinical utility. Ann Noninvasive Electrocardiol. 2005 Jan; 10(1):88-101 ("Kleiger 2005") (APPLE-1033)
- Chen Z, Brown EN, Barbieri R. Characterizing nonlinear heartbeat dynamics within a point process framework. IEEE Trans Biomed Eng. 2010 Jun; 57(6):1335-47 ("Chen 2010") (APPLE-1034)
- Karvonen, J., Vuorimaa, T. Heart Rate and Exercise Intensity During Sports Activities. Sports Medicine 5, 303–311 (1988) ("Karvonen 1988") (APPLE-1035)
- Yu C, Liu Z, McKenna T, Reisner AT, Reifman J. A method for automatic identification of reliable heart rates calculated from ECG and PPG waveforms. J Am Med Inform Assoc. 2006 May-Jun; 13(3):309-20 ("Yu 2006") (APPLE-1036)

- AliveCor v Apple ITC Complaint Exhibit 11 (731 Infringement Chart) (APPLE-1037)
- Tavassoli, & Ebadzadeh, Mohammad & Malek,. (2012). Classification of cardiac arrhythmia with respect to ECG and HRV signal by genetic programming. Canadian Journal on Artificial Intelligence, Machine Learning and Pattern Recognition. 3. 1-13 ("Tavassoli 2012") (APPLE-1038)
- Asl BM, Setarehdan SK, Mohebbi M. Support vector machine-based arrhythmia classification using reduced features of heart rate variability signal. Artif Intell Med. 2008 Sep;44(1):51-64 ("Asl 2008") (APPLE-1039)
- Yaghouby F., Ayatollahi A. (2009) An Arrhythmia Classification Method Based on Selected Features of Heart Rate Variability Signal and Support Vector Machine-Based Classifier. In: Dössel O., Schlegel W.C. (eds) World Congress on Medical Physics and Biomedical Engineering, September 7 - 12, 2009, Munich, Germany. IFMBE Proceedings, vol 25/4. Springer, Berlin, Heidelberg ("Yaghouby 2009") (APPLE-1040)
- Dallali, Adel & Kachouri, Abdennaceur & Samet, Mounir. (2011). Integration of HRV, WT and neural networks for ECG arrhythmias classification. ARPN Journal of Engineering and Applied Sciences. VOL. 6. 74-82 ("Dallali 2011") (APPLE-1041)

- Sajda P. Machine learning for detection and diagnosis of disease. Annu Rev Biomed Eng. 2006;8:537-65 ("Sajda 2006") (APPLE-1042)
- Aarron Smith. Smartphone Ownership – 2013 Update. Pew Research Center. June 5, 2013 ("Smith 2013") (APPLE-1043)
- C. Narayanaswami and M. T. Raghunath, "Application design for a smart watch with a high resolution display," Digest of Papers. Fourth International Symposium on Wearable Computers, 2000, pp. 7-14 ("Narayanaswami 2000") (APPLE-1044)
- Thong, YK & Woolfson, M & Crowe, JA & Hayes-Gill, Barrie & Challis, Richard. (2002). Dependence of inertial measurements of distance on accelerometer noise," Meas. Measurement Science and Technology. 13. 1163 ("Thong 2002") (APPLE-1045)
- AliveCor's ITC Complaint filed on April 20, 2021 in "Certain Wearable Electronic Devices With ECG Capability and Components Thereof" ITC-337-3545-20210420 ("ITC Complaint") (APPLE-1046)
- Marcovitch, Harvey. Black's Medical Dictionary. London: A. & C. Black, 2005 (APPLE-1047)
- U.S. Pat. No. 7,894,888 ("Chan") (APPLE-1048)
- Hu YH, Palreddy S, Tompkins WJ. A patient-adaptable ECG beat classifier using a mixture of experts approach. IEEE Transactions on Bio-medical

Engineering. 1997 Sep;44(9):891-900 ("Hu 1997") (APPLE-1049)

- Strath SJ, Swartz AM, Bassett DR Jr, et al. Evaluation of heart rate as a method for assessing moderate intensity physical activity. Medicine and Science in Sports and Exercise. 2000 Sep;32(9 Suppl):S465-70 ("Strath 2000") (APPLE-1050)
- U.S. Provisional Application No. 61/895,995 ("Martin Provisional") (APPLE-1054)
- AliveCor's District Court Complaint filed on May 25, 2021 in *AliveCor, Inc. v. Apple Inc.*, 3:21-cv-03958 (N.D.Cal. May 25, 2021) ("Antitrust Complaint") (APPLE-1055)

VII. TECHNOLOGY OVERVIEW

A. Arrhythmia

26. Cardiac arrhythmias refer to a group of disorders of the heart rate or heart rhythm. Atrial fibrillation is "the most common cardiac arrhythmia." APPLE-1001, 1:35-36. Arrhythmic activity can include the heart beating too fast (tachycardia), too slow (bradycardia), or irregularly (variations in heart rate). *Id.* While tachycardia and bradycardia may be diagnosed based on heart rate, variations in heart rate (e.g., atrial fibrillation) are diagnosed based on heart rate variability ("HRV") analysis. As a hypothetical example, when a patient goes into atrial fibrillation, a common rhythm disturbance, an HRV analysis would detect the

irregularity, even though the heart rate of the patient may stay with the normal range of between 60-100 bpm. For example, Tsipouras 2004 discloses detecting arrhythmia by training a machine learning algorithm (e.g., neural networks) with HRV data. APPLE-1012, Abstract. Tsipouras 2004 states that "Our study is based on the analysis of the RR-interval duration so the proposed method is capable of detecting arrhythmia types that produce irregularities on the RR intervals, the HRV or the heart rhythm." APPLE-1012, p. 106. Compared to looking at the raw heart rate signal (e.g., ECG), HRV analysis is more robust because it involves extracting the RR intervals and is less affected by noise. APPLE-1039, p. 52.

27. Since 1903, different detection techniques have been employed to detect irregular pulse rhythms or irregular heartbeats. *See, e.g.*, APPLE-1019 (describing use of a sphygmomanometer as early as 1924 to make "obvious the variation in the sound heard over the artery" to identify pulse irregularity); APPLE-1020, 9:12-28 (describing use of "plethysmogram" in 1997 to detect arrhythmia). By 1977, both detecting possible atrial fibrillation using irregular pulse rhythms or heartbeats and techniques to quantitatively characterize irregularities were well-known. By 2009, examples of known arrhythmia detection techniques included: neural networks, wavelet transforms, support vector machines, fuzzy logic and rule-based algorithms. APPLE-1040, p. 1928. A POSITA would have understood that many of these techniques (e.g., support

vector machines, neural networks) are machine learning algorithms.

B. Electrocardiography (ECG)

28. Eletrocardiography (ECG) measures the electrical activity of the heart, which can be indicative of various heart diseases. APPLE -1004, 1:14-17. ECG recording uses Ag/AgCl electrodes attached to specific anatomical positions. APPLE-1015, p. 635. Clinical ECG recording commonly uses 12 leads for determination of the complex temporal dynamics of each cardiac cycle. *Id*.

29. An ECG represents electrical activity of the heart based on depolarization and repolarization of the atria and ventricles, which typically show up as five distinct waves on the ECG readout—P-wave, Q-wave, R-wave, S-wave, and T-wave. A QRS complex is a combination of the Q, R, and S waves occurring in succession and represents the electrical impulse of a heartbeat as it spreads through the ventricles during ventricular depolarization. An R-R interval represents a time elapsed between successive R-waves of a QRS complex of the ECG that occur between successive heart beats. If R-R interval durations over a time period are close to one another in value, then ventricular rhythm is understood to be "regular." APPLE-1022, 110-112. In contrast, if there are significant variations in the R-R interval durations over a time period, then the ventricular rhythm is understood to be "irregular." *Id*.

30. In conventional clinical practice, ECG and telemetry are used at a

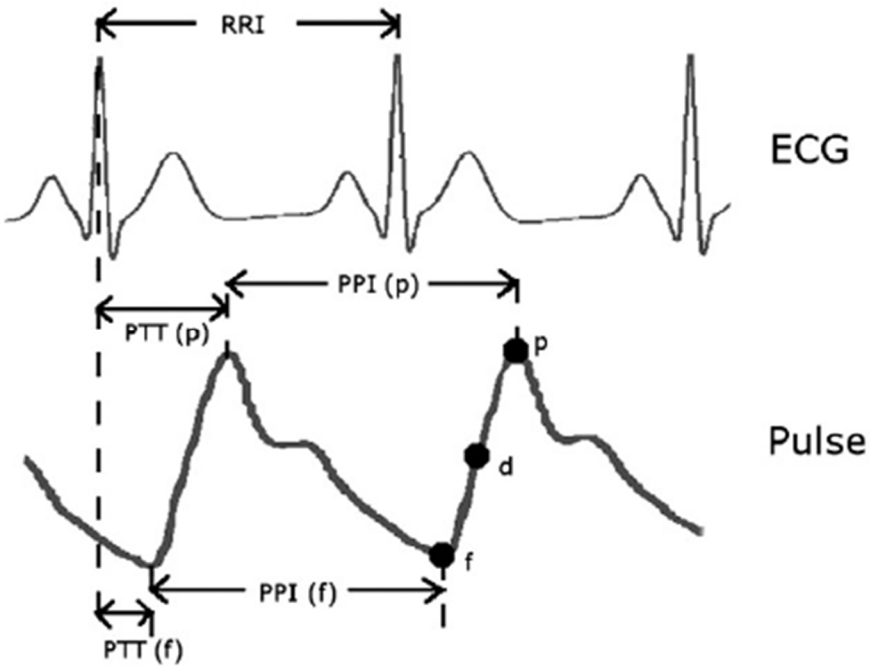
hospital to diagnose cardiac arrhythmias. APPLE-1016, p. 6080. As an irregular heartbeat caused by arrhythmia does not necessarily occur during examination at the hospital, a Holter ECG has been used for measuring one or more leads of an ECG in daily life. *Id*. A Holter ECG device is not ideal because it still requires attaching some electrodes to the patients' chest. *Id*. In addition, a Holter device typically only monitors the patient for a certain period (e.g., 24 hours, 48 hours and 72 hours) and thus it may not detect a cardiac arrhythmia if it does not occur during the monitoring period. APPLE-1004, 1:26-2:3.

C. Photoplethysmography (PPG)

31. Photoplethysmography (PPG) is a simple noninvasive optical technique for monitoring beat-to-beat relative blood volume changes in the microvascular bed of peripheral tissues. APPLE-1014, p. 479. PPG is sometimes also referred to as blood oxygen saturation, pulse oximeter, oximetry, and SpO2. APPLE-1004, 7:25-27. Its basic principle requires a light source to illuminate subcutaneous tissue and a photo detector with spectral characteristics matching those of the light source. APPLE-2018, p. 16.

32. As the pulse period derived from PPG data is directly related to cardiac activity, the physiological information derived from RR intervals of ECG can also be derived from the pulse period of a PPG reading. APPLE-1014, p. 480. This is because under normal conditions, the electrical impulse of the heart (ECG)

stimulates a cardiac contraction resulting in a spread of the pulsatile wave of blood to the periphery (PPG). APPLE-1014, p. 480. Thus, a PPG signal includes information about both heart rate and heart rate variability. APPLE-1025, p. 16. Many studies verify the high correlation between RR intervals (RRI) obtained from ECG and PP intervals (PPI) obtained from PPG. APPLE-1025, p. 16; APPLE-1018, Fig. 1.



APPLE-1018, Fig. 1.

33. Compared to ECG, PPG is attractive because it only requires attaching a single sensor to the hand of the user. APPLE-1018, p.16.

D. Heart Rate (HR)

34. Heart rate (HR) is the reciprocal of the RR interval and measures the number of heartbeats per unit of time. APPLE-1034, p. 5. It was long recognized

that an individual's heart rate varies with his/her activity level (exercise intensity). APPLE-1035, p. 303. As discussed above, an individual's heart rate and the corresponding RR interval can be determined using either ECG or PPG data. APPLE-1036, Abstract and Fig. 1.

E. Heart Rate Variability (HRV)

35. Heart rate variability (HRV) is defined as the variation of RR intervals with respect to time and reflects beat-to-beat heart rate (HR) variability. APPLE-1025, p. 16; APPLE-1012, p. 95. HRV analysis is an important tool in cardiology to help diagnose various types of arrhythmia. APPLE-1012, Abstract and pp. 95-96 ("Therefore, HRV analysis became a critical tool in cardiology for the diagnosis of heart diseases."). HRV analysis has become popular because heart rate (HR) is a nonstationary signal and its variation may contain indicators of heart diseases. APPLE-1024, Abstract.

36. By the Critical Date, it was known that HRV can be accurately determined based on either ECG data or PPG data. *See*, *e.g.*, APPLE-1013, Abstract ("Our results demonstrate that the parameters of PPGV are highly correlated with the parameters of HRV."); APPLE-1014, Abstract ("HRV can also be reliably estimated from the PPG based PP interval method."); APPLE-1015, Abstract ("Our results confirm that PPG provides accurate interpulse intervals from which HRV measures can be accurately derived in healthy subjects under

ideal conditions, suggesting this technique may prove a practical alternative to ECG for HRV analysis."). As described in the '731 patent, R-R intervals may be extracted from the raw heart rate signals (from PPG or ECG) and the R-R intervals may be used to calculate heart rate variability (HRV) in various ways using time-domain methods, geometric methods, frequency-domain methods, non-linear methods, long term correlations, or the like, as known in the art. APPLE-1001, 8:64-9:2 and Fig. 3. Kleiger 2005 discloses that methods for quantifying HRV are categorized as: time domain, spectral or frequency domain, geometric, and nonlinear. APPLE-1033, p. 88. SDNN, the standard deviation of all normal RR intervals during a 24-hour period, is a commonly used time domain measure of HRV. *Id*.

37. If the RR intervals over a time period are close to each other in value, then ventricular rhythm is understood to be "regular." APPLE-1022, 110-112. In contrast, if there are significant variations in the RR intervals over a time period, then the ventricular rhythm is understood to be "irregular." *Id*.

F. Machine Learning Algorithms

38. Machine learning, a subdiscipline in the field of artificial intelligence (AI), focuses on algorithms capable of learning and/or adapting their structure (e.g., parameters) based on a set of observed data, with adaptation done by optimizing over an objective or cost function. APPLE-1042, p. 538. Machine

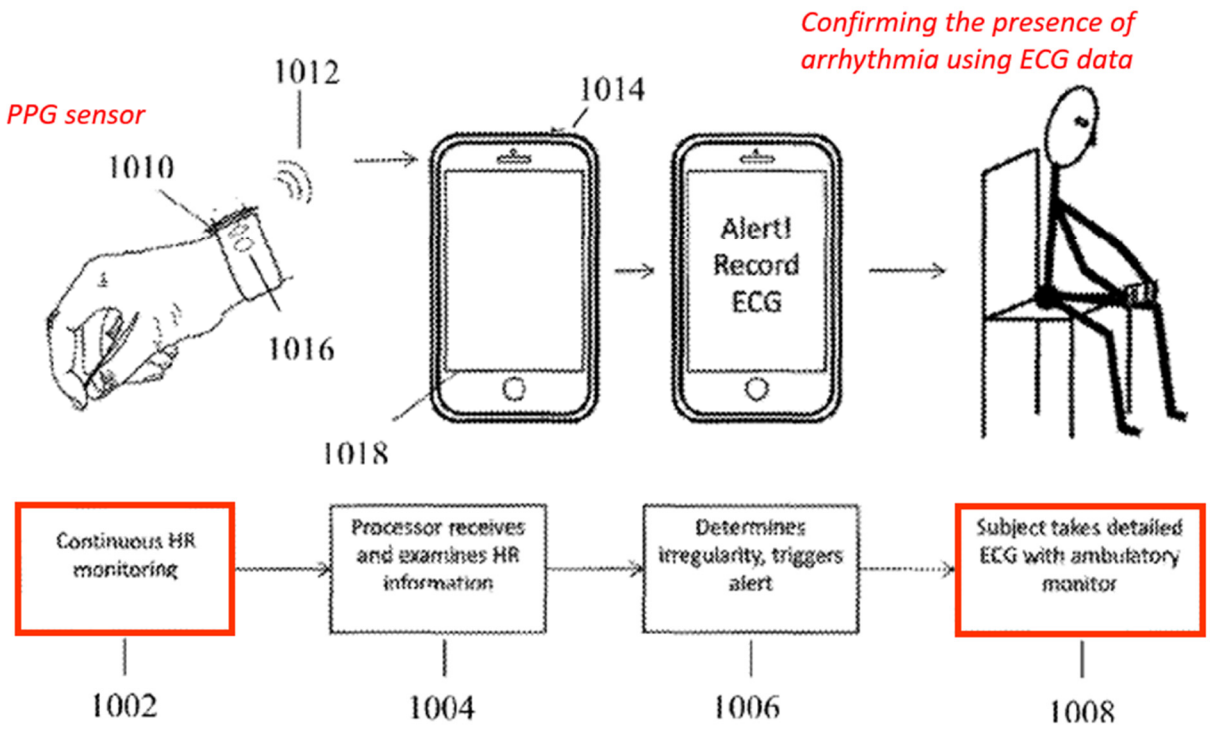
learning and statistical pattern recognition have been the subject of tremendous interest in the biomedical community because they offer promise for improving the sensitivity and/or specificity of detection and diagnosis of disease, while at the same time increasing objectivity of the decision-making process. *Id*. Machine learning offers a principled approach for developing sophisticated, automatic, and objective algorithms for analysis of high-dimensional and multimodal biomedical data. *Id*., Abstract.

VIII. OVERVIEW OF THE '731 PATENT

39. The '731 patent, titled "Methods and systems for arrhythmia tracking and scoring," claims a two-staged arrhythmia detection method where the first step uses a PPG monitor and the second step uses an ECG monitor. APPLE-1001, claim 1. Specifically, the '731 patent claims a method that includes: (1) receiving PPG data from a PPG sensor; (2) detecting arrhythmia based on the PPG data; (3) receiving ECG data from an ECG sensor, and (4) confirming arrhythmia based on the ECG data. *Id.*, claim 1. The '731 patent explains that the heart rate can be detected by using PPG. APPLE-1001, 8:51-55. The '731 patent further explains that an advisory condition for recording an ECG may occur due to large continuing fluctuations in heart rate, or when a measured heart rate increases rapidly without a corresponding increase in activity level. APPLE-1001, 25:25-30.

40. As shown below, Figure 10 depicts an example where the heart rate is

detected using a heart rate monitor 1010 (e.g., PPG sensor), an irregularity is detected, and an alert is provided for the user to record an ECG. APPLE-1001, 23:22-34 ("In FIG. 10, a subject is wearing a continuous heart rate monitor (configured as a watch 1010, including electrodes 1016), shown in step 1002. The heart rate monitor transmits (wirelessly 1012) heart rate information that is received by the smartphone 1018, as shown in step 1004. The smartphone includes a processor that may analyze the heart rate information 1004, and when an irregularity is determined, may indicate 1006 to the subject that an ECG should be recorded. In FIG. 10, an ambulatory ECG monitor 1014 is attached (as a case having electrodes) to the phone 1018. The user may apply the ECG monitor to their body (e.g. chest, between arms, etc.) 1008 to record ECGs that can then be saved and/or transmitted for analysis.").



APPLE-1001, Figure 10 (annotated)

IX. OVERVIEW OF THE PROSECUTION HISTORY

41. Applicant filed U.S. Patent Application 16/588,201 ("the '201 application") on September 30, 2019. APPLE-1001, Cover. The '201 application is a continuation application of U.S. Patent Application No. 16/153,446, filed on October 5, 2018, which is a continuation of U.S. Patent Application No. 15/393,077, filed on December 28, 2016, which is a continuation of U.S. Patent Application No. 14/730,122, filed on June 3, 2015, which is a continuation of U.S. Patent Application No. 14/569,513, filed on December 12, 2014, which claims priority to provisional application No. 62/014,516, filed on June 19, 2014,

provisional application No. 61/970,551, filed on March 26, 2014, provisional application No. 61/969,019, filed on March 21, 2014, provisional application No 61/953,616, filed on March 14, 2014, and provisional application No. 61/915,113,[1] filed on December 12, 2013. *Id*.

42. During prosecution of the '731 patent, the Examiner only issued a double-patenting rejection, which was overcome by filing a terminal disclaimer. APPLE-1002, pp. 73-78 (Non-Final Rejection dated November 25, 2019) and pp. 51-72 (Response dated January 8, 2020). During prosecution, the examiner did not consider Shmueli, Osorio, or Li.

43. Later, the Office allowed the application and noted in the Examiner's statement of reason for allowance that the cited reference fails to disclose the claimed invention having a smart watch and a method of determining a presence of arrhythmia comprising sensing an activity level with a motion sensor and comparing a heart rate variability to said activity level. APPLE-1002, 25-32 (Notice of Allowance, 2020-2-3). The '731 patent issued on March 24, 2020 and includes 30 claims, of which claims 1, 17 and 25 are independent. APPLE-1001, Cover and claims.

---

[1] The cover of the '731 patent lists provisional application No. 61/915,113 as "provisional application No. 61/915,115," which I understand as a typo.

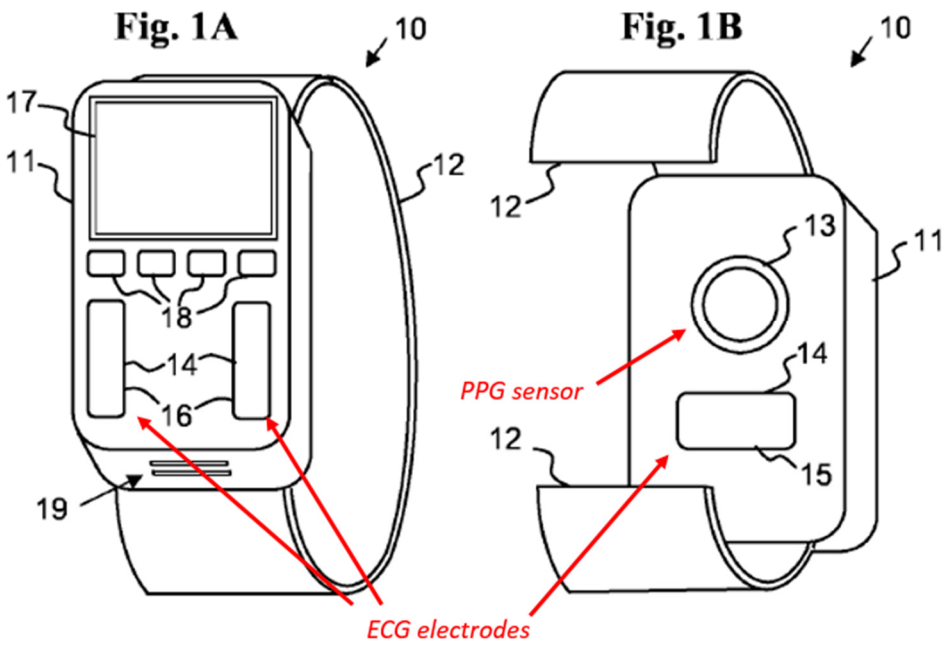
X. SUMMARY OF THE PRIOR ART

A. Shmueli

(a) *Monitoring Device*

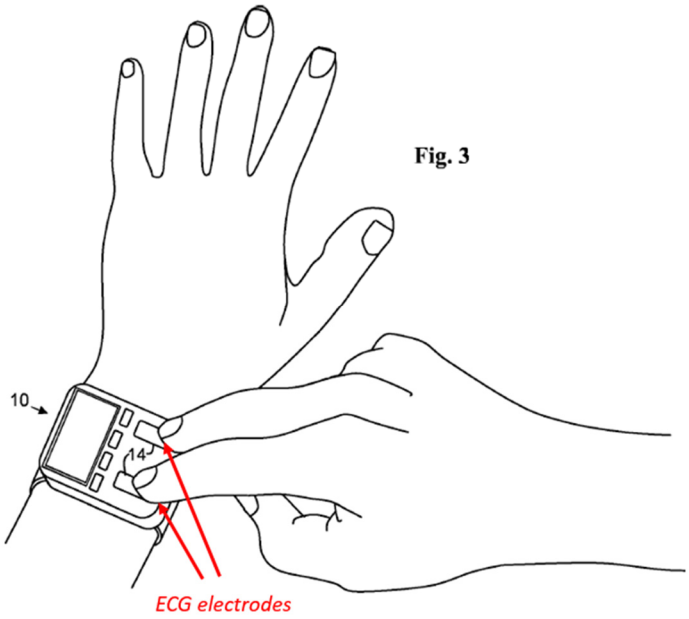
44. Shmueli is titled "Pulse oximetry measurement triggering ECG measurement." APPLE-1004, Cover. Shmueli's heart monitoring device includes an "oximetry measuring unit" for measuring oxygen saturation (SpO_2), which Shmueli describes as being the same as PPG. APPLE-1004, 7:25-27 ("In this document, unless otherwise specified, the terms 'oxygen saturation in the blood', 'blood oxygen saturation', 'pulse oximeter', oximetry, SpO2, and photoplethysmography[(PPG)] have the same meaning and may be used interchangeably"). The heart monitoring device also includes an "ECG measuring unit" with electrical contacts for measuring ECG, and a "processor" to control both types of measurements. APPLE-1004, 4:1-9 ("a wrist-mounted physiological parameters measuring device including: an SpO2 measuring unit attached to a wrist of a subject the SpO2 measuring unit being operative to continuously measure SpO2 at the wrist of the subject, an ECG measuring unit attached to the wrist of the subject for measuring ECG signal at least partially at the wrist, and a processor operative to control both the SpO2 measuring and the ECG measuring unit"), 9:8-16, 11:10-21.

45. Shmueli's heart monitoring device has a wrist-mounted form factor. *See* APPLE-1004, FIGS. 1A, 1B, 2-5.



APPLE-1004, Figs. 1A, 1B (annotated)

46. Figure 3 shows an example of a user using Shmueli's heart monitoring device on his/her wrist to collect an ECG measurement.



APPLE-1004, Fig. 3 (annotated)

(b) *Monitoring Technique*

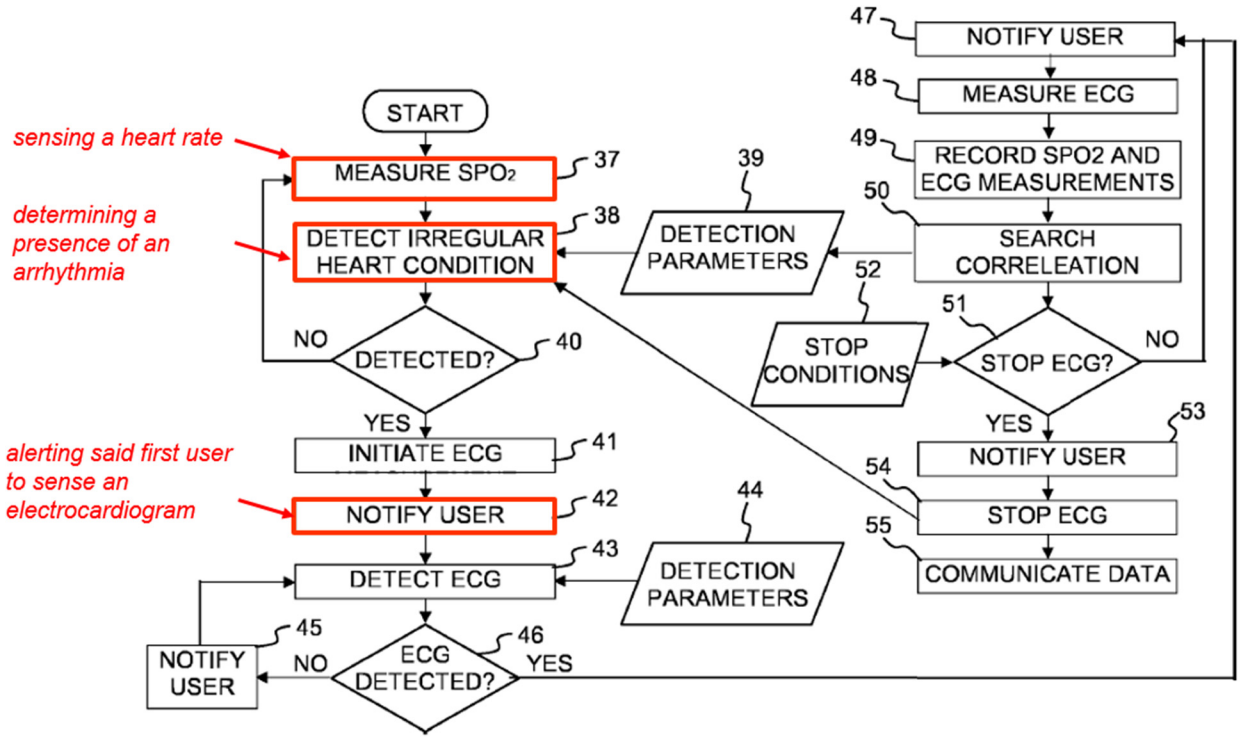
47. Shmueli's hearting monitoring device performs a monitoring technique that involves "continuously measuring [oxygen saturation (SpO_2)] at the wrist of the user, detecting an **irregular heart condition** from the SpO_2 measurement, notifying the user to perform an ECG measurement, and initiating the ECG measurement at least partially at the wrist." APPLE-1004, Abstract (emphasis added). PPG also is referred to as pulse oximetry SpO_2 (oxygen saturation). APPLE-1004, 7:25-27.

48. A POSITA would have understood that the term "irregular heart condition" refers to arrhythmia for several reasons. First, Shmueli's disclosure supports this understanding since Shmueli discloses both detecting the "irregular heart condition" based on PPG data and confirming the diagnosis with an ECG measurement. APPLE-1004, Abstract, FIG. 8; 8:23-28 ("The present invention resolves this problem by providing a combined oximetry and electrocardiogram measuring system and a method in which the oximetry measurement is performed continuously and/or repeatedly, and the ECG measurement is triggered upon detection of an intermittent irregular heart-related event."). Although "irregular heart condition" is not a standard term in medicine, a POSITA would have understood that this term refers to arrhythmia, which is one of the most obvious (if not the most obvious) types of "irregular heart condition[s]" that can be determined

using PPG and ECG data. APPLE-1016, p. 6081; APPLE-1020, Abstract, 44:29-32; APPLE-1011, Abstract. Indeed, the Merriam-Webster Dictionary defines "heart disease" as "an abnormal condition of the heart or of the heart and circulation (such as coronary heart disease, **arrhythmia**, or heart-valve defect)." APPLE-1023, 2. Similarly, the Black Medical Dictionary lists "**arrhythmia**" as the first condition under the heading "Heart, Disease of." APPLE-1047, 320-321. Likewise, the '731 patent describes arrhythmia as "a **cardiac condition** in which the electrical activity of the heart is **irregular**..." APPLE-1001, 1:40-42. Shmueli also recognizes that "[d]eriving heart rate from oximetry" was known in the art and was commonly understood to be used in detection of arrhythmias. APPLE-1004, 8:11-13. Shmueli also offers an expansive definition of the term "irregular heart condition." APPLE-1004, 15:3-5 ("It is expected that during the life of this patent many relevant methods and systems will be developed and the scope of the terms herein, particularly of the term 'irregular heart condition' are intended to include all such new technologies a priori."). If you google the term "irregular heart condition," the first page only refers to arrhythmias. A POSITA would assume that when this term is used in the patent, it is referring to a cardiac arrhythmia.

49. Like the '731 patent, Shmueli's heart monitoring device detects arrhythmia using PPG. APPLE-1004, Abstract. Shmueli's Figure 7 provides an example of its cardiac monitoring technique.

Fig. 7



APPLE-1004, Fig. 7 (annotated)

50. As shown above, Shmueli's heart monitoring device uses PPG data to detect an irregular heart condition (arrhythmia) at elements 37-38. APPLE-1004, 12:9-22 ("The software program proceeds to element 38 to derive from the SpO2 measurement physiological parameters such as pulse rate, pulse amplitude, pulse shape, rate of blood flow, etc. Then, the software program scans the derived physiological parameters to detect various irregularities of the heart condition."). If arrhythmia is detected at element 40, the heart monitoring device triggers an ECG measurement at element 41 by providing a notification to the user to take the ECG measurement at element 42. *Id.*, 12:23-32.

51. A POSITA would have understood and/or found obvious that the

monitoring technique shown in Shmueli's Figure 7 contemplates using ECG data to confirm the initial detection of an irregular heart condition using PPG data. *Id.*, 8:24-29. This is because Shmueli criticizes other heart monitoring devices for "not consider[ing] a requirement to enable a patient to perform ECG measurement as soon as an irregular heart activity develops and without requiring the ECG to be constantly wired to the patient." *Id.*, 8:21-24. A POSITA would have recognized that Shmueli's focus on enabling ECG measurements "as soon as" an irregular heart condition is detected enables ECG data to be used to confirm the detection of the irregular heart condition using PPG data, thereby improving detection accuracy compared to prior art heart monitoring devices. *See* APPLE-1004, 13:16-21 (describing that developing correlations between PPG data and ECG data provides the ability to "produce new detection parameters, or modify existing detection parameters, so as to enhance the detection algorithms of the irregular heart conditions").

B. Osorio

52. Osorio is titled "Pathological state detection using dynamically determined body data variability range values." APPLE-1005, Cover. Osorio's monitoring technique includes receiving a body signal of the patient and determining a body data variability (BDV) from the body signal. *Id.*, Abstract, [0003]. Osorio describes the body signal can be heart rate ("HR") and the BDV

can be heart rate variability ("HRV"). *Id.*, [0042]-[0043]; [0080] ("the body index value may be heart rate and the BDV may be HRV."). Osorio's monitoring technique also includes determining an activity level of a patient based on data from an activity sensor (e.g., accelerometer). *Id.* at [0035]. Osorio describes detecting a pathological state (e.g., arrhythmia) by comparing the current BDV value to a BDV non-pathological range that is determined based on the activity level. *Id.*, [0003] ("the present disclosure relates to a method of detecting a pathological body state of a patient, comprising receiving a body signal of the patient; determining a first body data variability (BDV) from said body signal; determining an activity level of said patient; determining a non-pathological range for said first BDV, based at least in part on said activity level; comparing said first BDV to said non-pathological range for said first BDV; and detecting a pathological body state when said BDV is outside said non- pathological range."). Figure 8 shows an example of Osorio's monitoring technique:

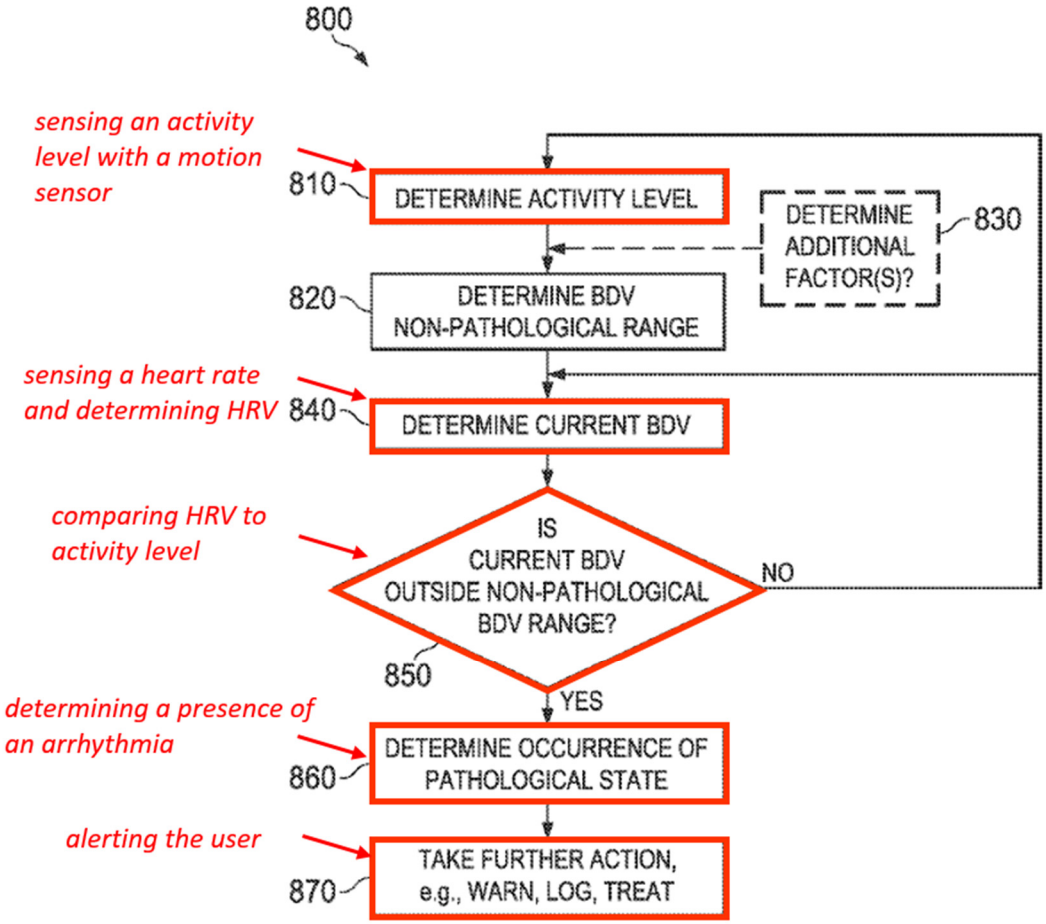


FIG. 8

APPLE-1005, Fig. 8 (annotated)

53. As shown above, an activity level is determined at 810, and a non-pathological BDV range is determined at 820 based on the activity level. APPLE-1005, [0077]. A current BDV is determined at 840 and compared to the non-pathological BDV range at 850. APPLE-1005, [0078]. If the current BDV is outside the non-pathological range, then a pathological state is determined at 860. *Id*. Thereafter, a further action, such as warning, treating, or logging the occurrence and/or severity of the pathological state is taken at 870. *Id*..

54. Osorio's detection of a pathological state encompasses detecting arrhythmia. APPLE-1005, [0046] (discussing detecting "a **tachycardia** episode."); [0071] (discussing detecting "**the emergence of one or more cardiac arrhythmias**"). A POSITA would have therefore understood and/or found obvious that Osorio's detection of a pathological state involves detecting an arrhythmia.

55. Osorio explains that accurate detection of a pathological condition (e.g., arrhythmia) based on a patient's HR should also consider the patient's activity level:

> This disclosure recognizes that to determine (using body systems and their features) whether a body system is functioning pathologically or non-pathologically with a clinically worthwhile degree of accuracy and reliability, **one must take into account the type and/or level of activity being performed by a subject at the time the pathological/non-pathological determination is made**. For example, if the objective is to determine if and when a patient is in a seizure state that manifests with increases in heart rate, it is imperative to know whether or not a given increase in heart rate is associated with a change in activity (e.g., physical or emotional) and if such a change in activity is occurring, **to determine if the heart rate increase is commensurate with said activity type and level**. This may be accomplished by a dynamical adjustment of value ranges of body signal features to avoid false diagnoses.

APPLE-1005, [0029].

56. Based on this disclosure, a POSITA would have understood that accurate detection of a pathological condition (e.g., arrhythmia) benefits from monitoring body data (e.g., HR) and activity level in tandem. Osorio recognizes that both HR and activity level affect the non-pathological BDV range and, thus, affect the detection of a pathological condition (e.g., arrhythmia) using the non-pathological BDV range. APPLE-1005, [0058] (describing that "[b]oth the upper and lower bounds of the [non-pathological] HR range increase as activity level increases (e.g., from a sleep state to a resting, awake state) and reach their highest values for strenuous exertion.").

57. Osorio's Figure 4A (below) show examples of HR variability as a function of activity level, which is then used to determine different non-pathological BDV ranges at different activity levels:

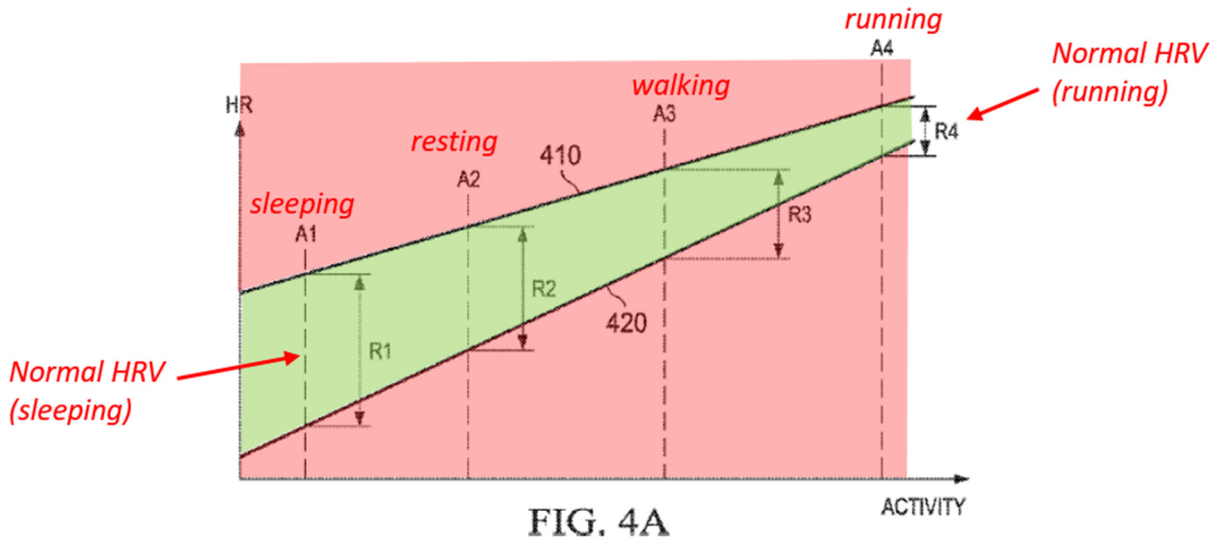


FIG. 4A

APPLE-1005, Figs. 4A (annotated)

58. As shown, a patient's activity level is shown on the x-axis and the patient's HR is shown on the y-axis. APPLE-1005, [0057]. BDV is represented by HRV, which is represented in Figure 4A by bars R1-R4. *Id.* Non-pathological BDV (HRV) ranges are illustrated in green and BDV (HRV) values outside the non-pathological BDV ranges are illustrated in red. *Id.* In Figure 4A, a unique non-pathological BDV (HRV) range (R1, R2, R3, R4) is determined for each of four different activity levels A1, A2, A3, A4 represented by sleeping, resting, walking, and running, respectively. *Id.* The dynamic relationship between HR, HRV, and activity level is used to detect pathological states by "determining when the patient's HRV is incommensurate with the patient's activity level and/or heart rate." APPLE-1005, [0066] ("The dynamic relationship between non-pathological HRVs and activity levels may be exploited to detect pathological states such as epileptic seizures by determining when the patient's HRV is incommensurate with the patient's activity level and/or heart rate.").

C. Li 2012 Overview

59. Li 2012, titled "signal quality and data fusion for false alarm reduction in the intensive care unit," discloses using a machine learning algorithm to detect arrhythmia based on PPG and ECG data. APPLE-1006, Abstract. Li 2012 explains that traditional arrhythmia detection was marred by false alarms due to a lack of

integration between different sensors. APPLE-1006, Abstract. To solve this problem, Li 2012 utilized a machine learning algorithm to combine up to 114 features extracted from PPG and ECG data. APPLE-1006, Abstract. Li 2012 demonstrates that its machine learning algorithm can reduce false alarm by more than 30% (29.84% on training, 30.46% on test data) with a true alarm suppression rate below 1%. APPLE-1006, p. 7 and Table 6.

D. Kleiger 2005 Overview

60. Kleiger 2005, titled "Heart rate variability: measurement and clinical utility," is a review article on the common HRV measurements and their clinical utility. APPLE-1033, Title. Kleiger 2006 discloses that HRV, also referred to as RR interval variability, is useful for assessing risk of cardiovascular death or ***arrhythmia*** events. APPLE-1033, Abstract. Kleiger 2005 discloses that methods for quantifying HRV are categorized as: time domain, spectral or frequency domain, geometric, and nonlinear. APPLE-1033, p. 88.

(c) *Time domain HRV measures*

61. Kleiger 2005 explains that, in time domain analysis, the intervals between adjacent normal R waves (NN intervals) are measured over the period of recording. APPLE-1033, p. 88. Kleiger 2005 discloses common time domain HRV measures in Table 1:

Table 1. Time Domain Measures of HRV Calculated over 24 Hours

SDNN	Standard deviation of all normal to normal R-R (NN) intervals
SDANN	Standard deviation of 5-minute average NN intervals
ASDNN (index)	Mean of the standard deviations of all NN intervals for all 5-minute segments in 24 hours
rMSSD	Square root of the mean of the squares of successive NN interval differences
NN50	The number of NN intervals differing by >50 ms from the preceding interval
pNN50	The percentage of intervals >50 ms different from preceding interval
Night-day difference	Mean night R-R interval minus mean day R-R interval

APPLE-1033, Table 1.

As one example, Kleiger 2005 discloses that SDNN, the standard deviation of all normal RR (NN) intervals during a 24-hour period, is the most commonly used time domain measure of HRV. APPLE-1033, p. 88.

(d) ***Spectral or frequency domain HRV measures***

62. Regarding spectral or frequency domain HRV measures, Kleiger 2005 explains that either fast Fourier transformation or auto-regression techniques can be used to quantify cyclic fluctuations of R-R intervals. APPLE-1033, p. 89. Traditionally, spectral analysis has been done in short-term laboratory studies; often standard 5-minute ECG segments are analyzed. *Id*. Two peaks are seen in 5-minute R-R interval power spectra, a HF peak between 0.15 and 0.40 Hz and a low frequency (LF) peak between 0.04 and 0.15 Hz. *Id*.

63. As shown below in Table 2, Kleiger 2005 explains that each of the 24-hour spectral measures has an equivalent time domain variable, which is highly correlated with it because both are influenced by the same physiologic inputs and because of mathematical relationships. APPLE-1033, p. 90.

Table 2. Highly Correlated Time and Spectral Measures of HRV

Time Domain	Frequency Domain
SDNN	Total power
SDANN	ULF power
ASDNN	VLF power
PNN50, rMSSD	HF power
Highly Correlated Time Domain Measures	
SDNN	SDANN
RMSSD	pNN50

APPLE-1033, Table 2.

(e) ***Geometric HRV measures***

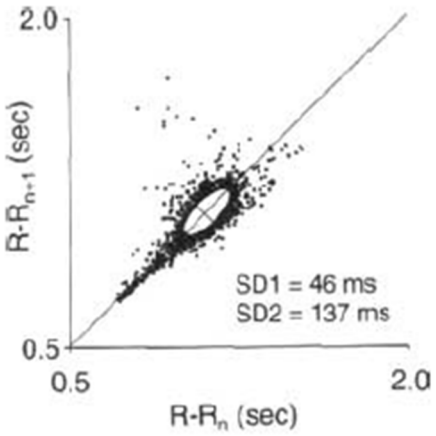
64. Regarding geometric HRV measures, Kleiger 2005 discloses that HRV triangular index, a geometric measure of HRV, has been used extensively by investigators at St. George's Hospital in London. APPLE-1033, p. 91. In this method, the calculation of HRV index minimizes the influence of outlier R-R intervals, i.e., those much longer or shorter than the usual, thereby substantially reducing the influence of missed beats, artifact, and ectopic complexes. *Id*.

(f) ***Nonlinear HRV measures***

65. Although time and frequency domain measures of HRV quantify HRV on various time scales, nonlinear HRV measures attempt to quantify the structure or complexity of the R-R interval time series. APPLE-1033, p. 91. For example, a random series of R-R intervals, a normal series of R-R intervals and a totally periodic series of R-R intervals might have the exact same SDNN, but their

underlying "organization" would be completely different. *Id*. A large number of nonlinear measures of HRV have been studied, but only a few have shown clear utility in risk stratification. *Id*. These include the power law slope, the short- and long-term fractal-scaling exponent, and SD12, a measure derived from Poincare plots. *Id*.

66. Kleiger 2005 explains that the Poincare graph plots ***each RR interval as a function of the next RR interval*** and provides an excellent way to visualize patterns of R-R intervals. APPLE-1033, p. 92 and Fig. 2. Kleiger 2005 also explains that the Poincare plot is a ***nonlinear*** measure of the ***RR interval fluctuations***. *Id*., Fig. 2.



APPLE-1033, Fig. 2.

67. Poincare plots that reveal abnormal R-R interval patterns have been characterized as "complex." APPLE-1033, p. 92. SD12 is determined by fitting an ellipse to the Poincare plot. *Id*. SD1 is the short axis of this ellipse and SD2 is the

long axis. *Id*. SD12 is their ratio. *Id*. As the plot becomes more complex, the relative magnitude of SD1 compared to SD2 increases and SD12 becomes larger. *Id*. In addition, if the plot is small and ball-shaped because of relatively constant R-R intervals, SD12 also will be large. *Id*.

E. Chan Overview

68. Chan is titled "device and method for measuring three-lead ECG in a wristwatch." APPLE-1048, Cover. Chan discloses a "wristwatch worn by a user for measuring a three-lead ECG." APPLE-1048, Abstract. Figs. 1A and 1B show front and back views of Chan's device. APPLE-1048, 2:43-49. In the backside 1 of the watch, an electrode 3 is inserted for touching the hand that wears the watch. *Id*. The frontside 2 of the watch includes electrode 4 and electrode 6 for fingers from the other hand to press on. *Id*. A display 7, such as a liquid crystal display (LCD), is on the frontside 2 of the watch. *Id.* The display 7 can demonstrate in text 15, which includes time, heart rate, condition (normal or arrhythmia), and graph/animation, an event 13 and ECG waveforms 14. *Id*.

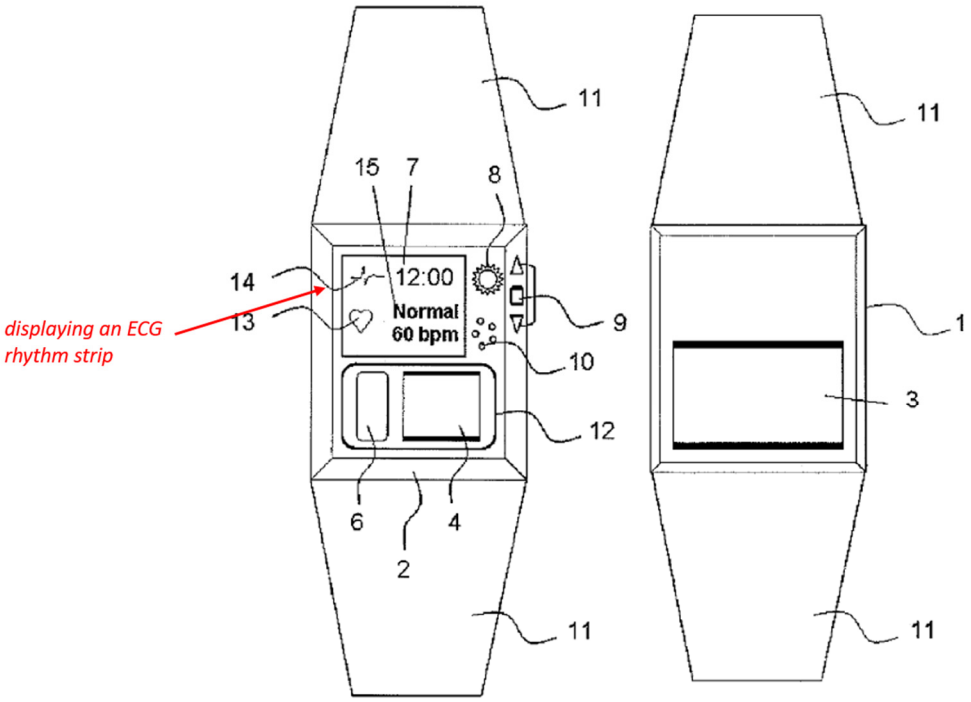
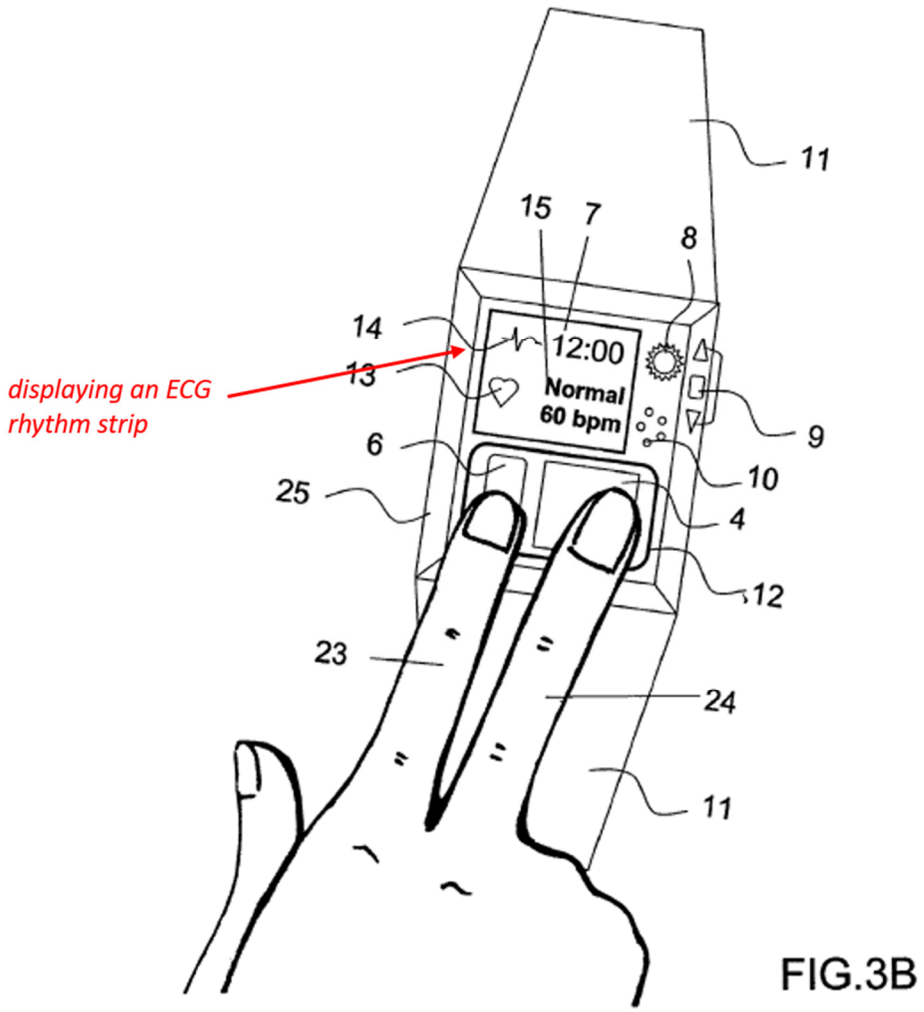


FIG.1A FIG.1B

APPLE-1045, Figs. 1A and 1B (annotated).

69. Fig. 3B of Chan shows an example of using Chan's device to measure an ECG. APPLE-1048, Fig. 3B. In Fig. 3B, Chan's watch 25 is worn tightly on one hand and one finger 23 from the other hand 21 presses on the sensing element 6, and another finger 24 from the other hand 21 presses on the electrode 4 on the front 2 of the watch simultaneously. APPLE-1048, 3:5-13.



APPLE-1045, Fig. 3B (annotated).

XI. ANALYSIS OF SHMUELI

70. For the reasons articulated in detail below, and based on my review of the '731 patent, the file history, and the prior art references cited here, it is clear that a POSITA would have readily understood that the teachings of Shmueli provide all the elements of claims 1, 7, 12, 13, 16, 17, 23-26 and 30.

A. Claim 1

[1.0] A smart watch to detect the presence of an arrhythmia of a user, comprising:

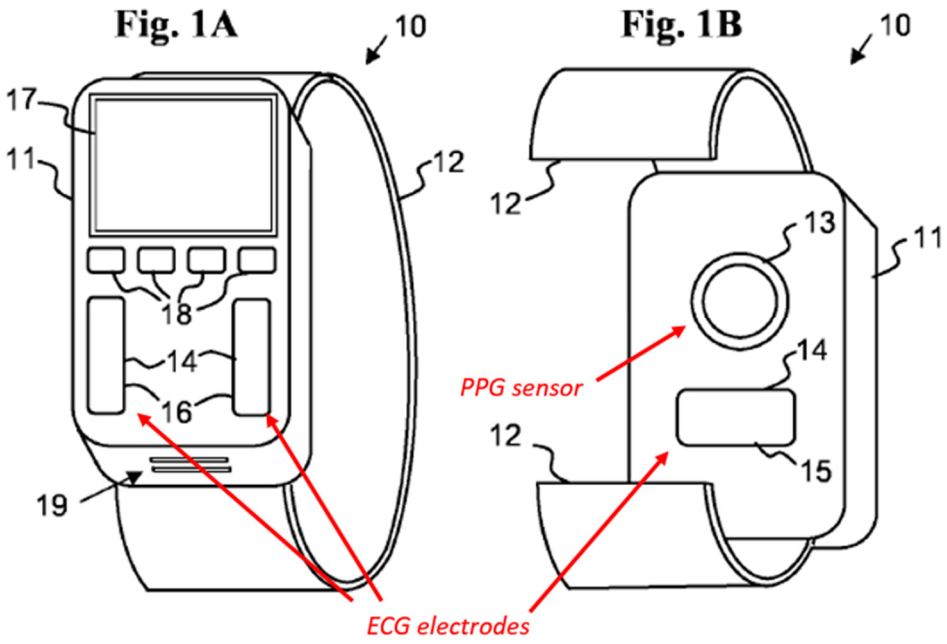
71. To the extent the preamble is limiting, it is my opinion that Shmueli renders obvious element [1.0].

72. Shmueli teaches "continuously measuring SpO_2 at the wrist of the user, detecting an **irregular heart condition** from the SpO_2 measurement, notifying the user to perform an ECG measurement, and initiating the ECG measurement at least partially at the wrist." APPLE-1004, Abstract. The Merriam-Webster Dictionary defines "heart disease" as "an abnormal condition of the heart or of the heart and circulation (such as coronary heart disease, arrhythmia, or heart-valve defect)." APPLE-1023, p.2. The '731 patent also defines arrhythmia as an irregular heart condition. APPLE-1001, 1:40-42 ("Arrhythmia is a cardiac condition in which the electrical activity of the heart is irregular…"). Similarly, the Black Medical Dictionary lists arrhythmia as the first condition under the heading "Heart, Disease of." APPLE-1047, pp. 320-321. Thus, a POSITA would have understood the term "irregular heart condition" refers to arrhythmia. Indeed, Shmueli offers an expansive meaning for the term "irregular heart condition," explaining that "[i]t is expected that during the life of this patent many relevant methods and systems will be developed and the scope of the terms herein, particularly of the term 'irregular heart condition' are intended to include all such new technologies a priori." APPLE-1004, 15:3-5.

73. A POSITA would have found it obvious to use Shmueli's SpO2 measurement to detect arrhythmia as the irregular heart condition because using PPG data to detect arrhythmia was well-known and arrhythmia was a well-known heart condition. APPLE-1016, p. 6081 (discussing detecting arrhythmia using PPG data); APPLE-1020, Abstract and 44:29-32. In addition, Shmueli discloses both detecting the "irregular heart condition" based on PPG data and confirming the diagnosis with an ECG measurement. APPLE-1004, Abstract and Fig. 8. An irregular heart condition is not a standard term in medicine. If you google the term, the first page only refers to arrhythmias. A POSITA would assume that when this term is used in the patent, it refers to a cardiac arrhythmia. Arrhythmia is one of the most obvious (if not the most obvious) types of "irregular heart condition[s]" that can be determined using both PPG and ECG data. ECG measurements are taken to detect rhythm abnormalities (e.g., arrhythmias) of a patient's heart. Because Shmueli uses ECG to confirm the irregular heart condition detected using PPG data, a POSITA would have understood that Shmueli discloses and/or renders obvious that Shmueli's detection of irregular heart conditions using PPG data includes detection of arrhythmias. For example, Lee 2013 discloses using PPG data and ECG data to detect atrial fibrillation, one of the most common type of arrhythmia. APPLE-1011, Abstract. For these reasons, based on Shmueli's disclosure of a method of detecting an irregular heart condition from SpO2 and

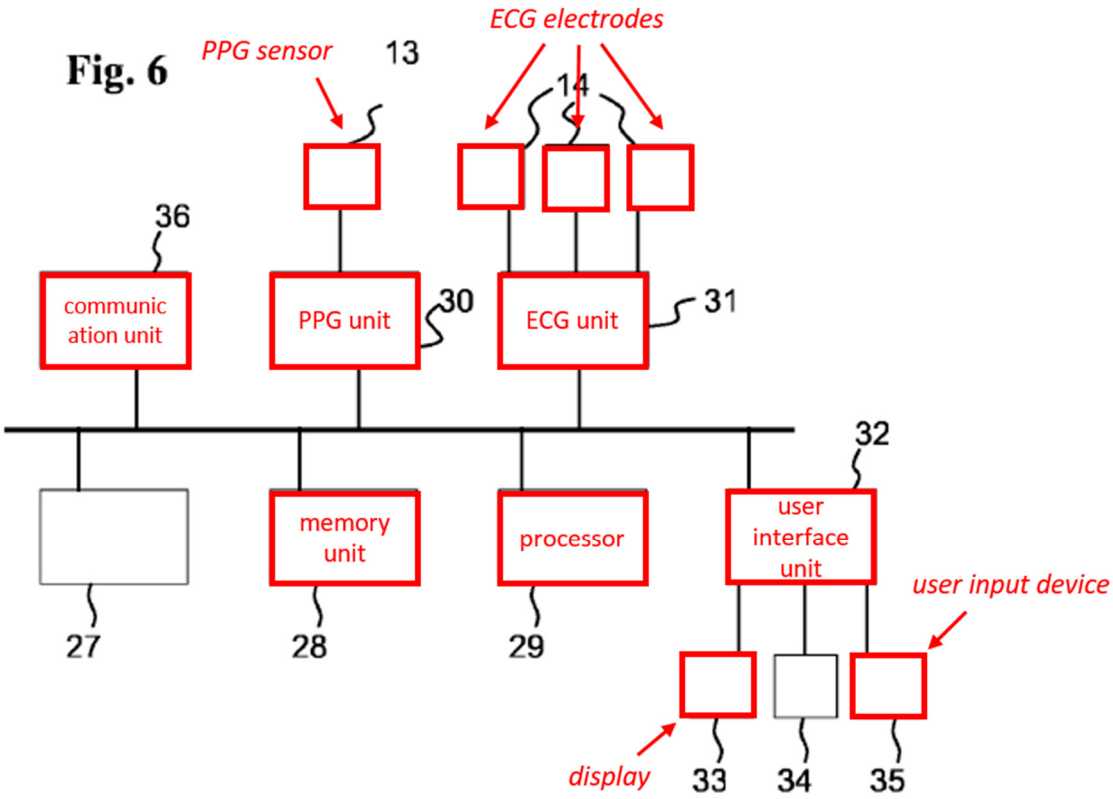
ECG measurements, Shmueli renders obvious a method of determining a presence of an arrhythmia of a first user.

74. Figs. 1A and 1B illustrate an example of Shmueli's device.



APPLE-1004, Figs. 1A and 1B (annotated).

75. As shown in Fig. 6, Shmueli's device includes "a power supply unit such as a battery 27, a memory unit 28, a processor 29, an oximetry measuring unit 30 with the oximetry sensor 13, an ECG measuring unit 31 with three ECG contact sensors 14, a user interface unit 32 preferably containing output devices such as a display 33 and a sound producing device 34, and a user input device 35 for example including buttons, and optionally a communication unit 36." APPLE-1004, 11:10-15.



APPLE-1004, Fig. 6 (annotated).

76. This is highly similar to the '731 patent's smartwatch that includes a heart rate monitor 1402, an activity monitor 1404, a processor coupled to a memory, and an output device 1408. APPLE-1001, 24:66-25:6. Thus, a POSITA would have understood that Shmueli's mobile computing device is a "smartwatch" within the meaning of the '731 patent.

77. In addition, the concept of using a smartwatch for heart rate monitoring was well-known by the Critical Date and, to the extent Patent Owner argues that Shmueli's wrist-worn device is not a smartwatch, a POSITA would have found it obvious to implement Shmueli's wrist-worn device as a smartwatch.

As early as 2000, there were commercial smart watch products that monitored heart rate. APPLE-1044, p.7 ("Polar produces heart monitor watches (Smart Edge™, Beat™, Protrainer NV™, Lady Beat™, Target™, Pacer™).") and p. 8 (discussing the Casio VDU 200B™ watch with a touch screen). For instance, Tran discloses a smartwatch that can detect arrhythmia with motion, PPG, and ECG sensors. *See* APPLE-1007, Fig. 6A, [0280]-[0282], [0288], [0315], [0387]-[0389] and [0479]. Similarly, Yuen discloses a smartwatch that can detect heart rate with PPG and motion sensors. *See* APPLE-1008, Fig. 8, [0015], [0046] and [0182]. Yuen also discloses that the smartwatch includes various applications including a swimming app, bicycling app, a programmable or customizable watch face, stop watch, music player controller (e.g., mp3 player remote control), text message and/or email display or "notifier", navigational compass, bicycle computer display, weight lifting tracker, sit-up reps tracker, etc. APPLE-1008, [0180]-[0183]. Yuen also discloses that if a bluetooth-enabled smart phone comes within reach of the smartwatch, the smartwatch may transmit data to or receive data from the Internet through the smart phone's cell phone network. APPLE-1008, [0160]. As another example, Martin discloses a smartwatch with motion, PPG, and ECG sensors that can be used to determine heart rate variability. APPLE-1009, Figs. 2-4, 7, [0067] and [0065] ("the multifunction button 320 may be integrated into a touch-screen of the wristwatch device 310"); APPLE-1054, [0021]. As discussed in an article

published in 2000, there are various design options for the input device on the smart watch including a keyboard, a touch-screen or a scrolling mechanism. APPLE-1044, p.8. The same article also indicates that the smart watch should include a user interface that allows for easy navigation between functions/applications including telling time, setting alarms, and personal information management (e.g., calendar, phone book, to dos). APPLE-1044, p.9. Known functions of a smart watch at the time included watch functions, personal information management (PIM) application (calendar, phone book, to dos), games, and an MP3 music player. APPLE-1004, p.10. Thus, a POSITA would have found it obvious to implement Shmueli's wrist-worn device in a smartwatch given the well-known nature of smartwatches and the visual and functional similarity between smartwatches and Shmueli's wrist-worn device. Thus, Shmueli renders obvious [1.0].

78. Further, in a recently-filed Antitrust Complaint, AliveCor argues for a narrow definition of the term "smartwatch," alleging that a "smartwatch is a mobile computing device with a touchscreen display that is typically worn on the wrist." APPLE-1055, p.30. However, nothing in the '731 patent suggests that a smartwatch must have a touchscreen. Indeed, the '731 patent never uses the term "touchscreen" and does not describe a "touchscreen" as being a part of its example smartwatch. Apple-1001, 24:66-25:12 (describing smart watch 1400 as including

heart rate monitor 1402, activity monitor 1404, and output device 1408). Moreover, as of the Critical Date, touchscreens were considered optional input devices for smartwatches and there were smartwatches that did not employ a touchscreen. *See* APPLE-1044, p.7 (discussing the Polar smartwatches) and p.8 (discussing the RexPro 5-DS™ smartwatch). In fact, the relative size of a watch face and a human finger limited the number of distinguishable touch zones, and thus some smartwatches used other input devices, such as scrolling mechanisms. APPLE-1044, p.8. Thus, despite AliveCor's contentions in the Antitrust Complaint, no basis exists for limiting the claimed "smartwatch" to a device including a touchscreen. Nevertheless, even if the term "smartwatch" is construed narrowly to require a touchscreen, a POSITA would have found it obvious to use a touchscreen as the selected input device for the Shmueli-Osorio device. Specifically, a POSITA would have understood that a touchscreen was one of a few obvious input options for a smartwatch. APPLE-1009, [0065] ("the multifunction button 320 may be integrated into a touch-screen of the wristwatch device 310"); APPLE-1054, [0021]; APPLE-1044, p.8 (discussing the Casio VDU 200B™ watch with a touch screen). As evidenced by these references, a POSITA would have had the general knowledge that a touchscreen was an available input device for a watch device, like Shmueli's, and would have found it obvious to employ a touchscreen as the input device for the Shmueli-Osorio device. *Id.*

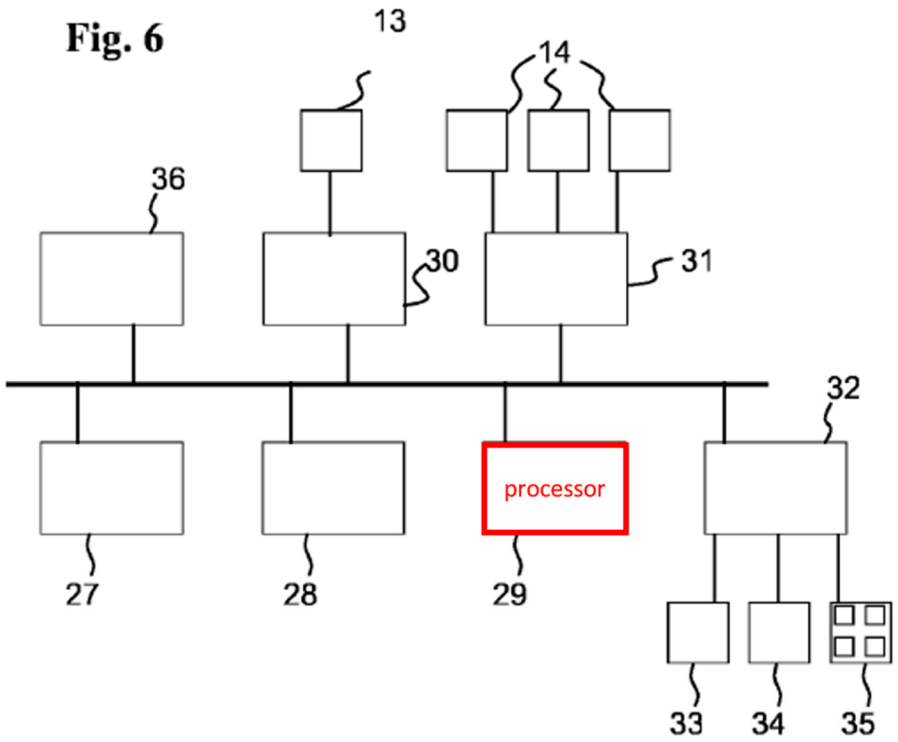
AliveCor's Antitrust Complaint also alleges that a smartwatch has "the ability to use multiple types of apps and easily select between them." APPLE-1055, p.30. Again, and similar to touchscreen, nothing in the '731 patent suggests that a smartwatch must have this functionality. Indeed, the '731 patent lacks disclosure of selecting among multiple types of apps and consistently refers only to a single "application." Apple-1001, 2:44-53. Nevertheless, a POSITA would have found selection among multiple types of apps obvious to implement in the Shmueli-Osorio device based on a POSITA's general knowledge of that type of functionality in smartwatches available as of the Critical Date. For example, Narayanaswami 2000 discloses that a smartwatch should include a user interface that allows for easy navigation between functions/applications including telling time, setting alarms, and personal information management (e.g., calendar, phone book, to dos). APPLE-1044, p.9. Yuen also discloses that the smartwatch includes various applications including a swimming app, bicycling app, a programmable or customizable watch face, stop watch, music player controller (e.g., mp3 player remote control), text message and/or email display or "notifier", navigational compass, bicycle computer display, weight lifting tracker, sit-up reps tracker, etc. APPLE-1008, [0180]-[0183]. As evidenced by these references, a POSITA would have had the general knowledge that selection among multiple types of apps was well-known and would have found it obvious to employ in the Shmueli-Osorio

device. Further, AliveCor's Antitrust Complaint alleges that a smartwatch can act as an extension of a user's smartphone. APPLE-1055, p.30. Although, again, nothing in the '731 patent suggests that this feature is required in a smartwatch, a POSITA would have found this feature obvious. For example, Shmueli discloses that the wrist-mounted heart monitoring device may communicate with a cell phone. APPLE-1004, 14:19-21. Yuen also discloses that if a Bluetooth-enabled smart phone comes within reach of the device, the device may transmit data to or receive data from the Internet through the smart phone's cell phone network. APPLE-1008, [0160]. Based on Shmueli's disclosure and the knowledge of a POSITA that watch devices served as extensions of smartphones, a POSITA would have found it obvious that the Shmueli-Osorio device act as an extension of a user's smartphone.

[1.1] a processing device

79. It is my opinion that Shmueli renders obvious element [1.1]. Shmueli discloses a processing device. APPLE-1004, 4:1-9 (discussing a "wrist-mounted physiological parameters measuring device including: an SpO2 measuring unit," "an ECG measuring unit" and a "***processor*** operative to control both the SpO2 measuring and the ECG measuring unit."). As shown in Fig. 6 below, Shmueli's heart monitoring device includes "a memory unit 28, **a processor 29**, an oximetry measuring unit 30 with the oximetry sensor 13, an ECG measuring unit 31 with

three ECG contact sensors 14." APPLE-1004, 11:10-15. A POSITA would have understood that Shmueli's device contains a processing device because it has a **processor** operative to control both SpO2 and ECG measuring. APPLE-1004, 4:1-9 (discussing "a processor operative to control both the SpO2 measuring and the ECG measuring unit."). Thus, Shmueli renders obvious [1.1].



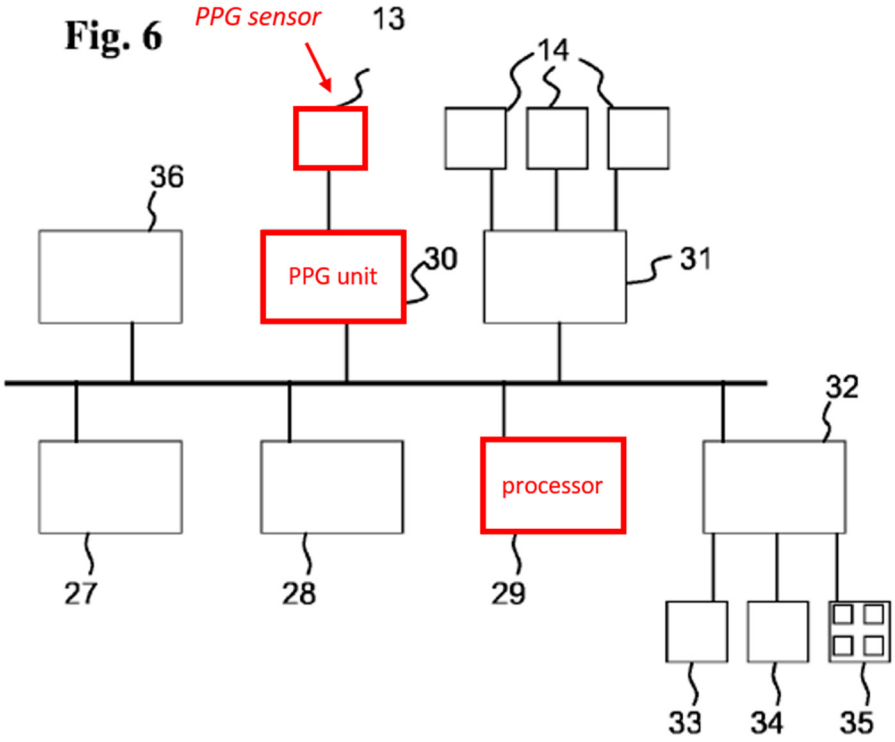
APPLE-1004, Fig. 6 (annotated).

[1.2] a photoplethysmography ("PPG") sensor operatively coupled to the processing device;

80. It is my opinion that Shmueli renders obvious element [1.2].

81. Shmueli discloses a PPG sensor operatively coupled to the processing device. APPLE-1004, 4:1-9 (discussing a "wrist-mounted physiological parameters

measuring device including: ***an SpO2 measuring unit***," "an ECG measuring unit" and a "processor operative to control both the SpO2 measuring and the ECG measuring unit."). As shown in Fig. 6 below, Shmueli's heart monitoring device includes "a memory unit 28, a processor 29, **an oximetry measuring unit 30 with the oximetry sensor 13**, an ECG measuring unit 31 with three ECG contact sensors 14." APPLE-1004, 11:10-15.



APPLE-1004, Fig. 6 (annotated).

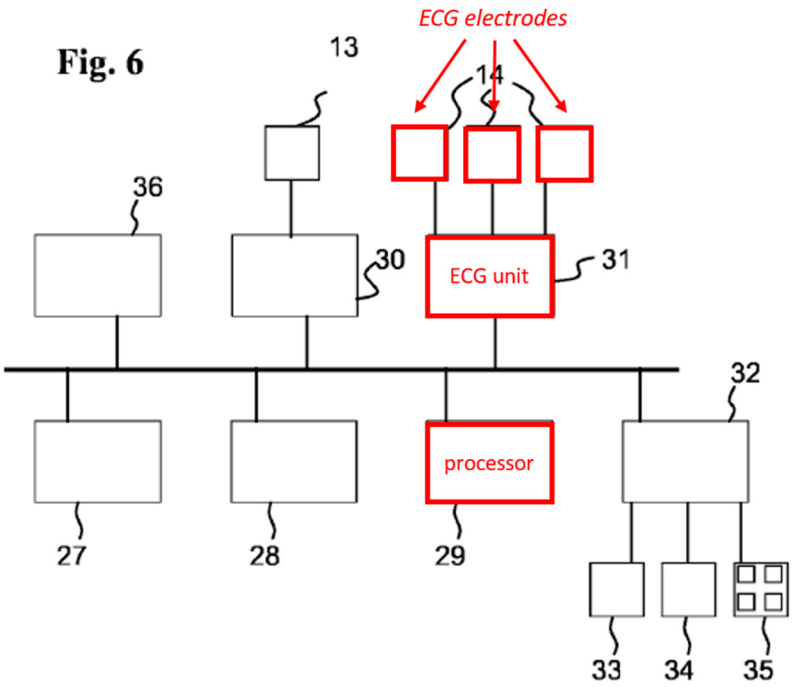
82. A POSITA would have understood that Shmueli's device includes a PPG sensor operatively coupled to the processing device because it has an "**oximetry measuring unit 30 with the oximetry sensor 13**" that is under the control of processor 29. Shmueli discloses that the terms "**oximetry**" and

"**photoplethysmography" (PPG)** have the same meaning and may be used interchangeably. APPLE-1004, 7:25-31. Thus, Shmueli renders obvious [1.2].

[1.3] an ECG sensor, comprising two or more ECG electrodes, the ECG sensor operatively coupled to the processing device;

83. It is my opinion that Shmueli renders obvious element [1.3].

84. Shmueli discloses an ECG sensor operatively coupled to the processing device. APPLE-1004, 4:1-9 (discussing a "wrist-mounted physiological parameters measuring device including: an SpO2 measuring unit," "***an ECG measuring unit***" and a "processor operative to control both the SpO2 measuring and the ECG measuring unit."). As shown in Fig. 6 below, Shmueli's heart monitoring device includes "a memory unit 28, a processor 29, an oximetry measuring unit 30 with the oximetry sensor 13, **an ECG measuring unit 31 with three ECG contact sensors 14**." APPLE-1004, 11:10-15.



APPLE-1004, Fig. 6 (annotated).

85. Shmueli also discloses that the three ECG contact sensors are attached to different parts of the user's body:

> Additionally according to another aspect of the present invention there is provided a wrist-mounted physiological parameters measuring device where the ECG measurement unit includes at least two separate conductive areas configured to measure electrical activity of the subject, where the at least three conductive areas arranged in one of the following configurations: a first conductive area configured to be in contact with at least a portion of the wrist, and second conductive area configured to be touched by a finger of a second hand of the subject, a first conductive area configured to be in contact with at least a portion of the wrist, and second and third conductive areas configured to be touched by two fingers of a second hand of the subject, and a first and a second conductive areas configured to be in contact with at least a portion of the first hand and a third conductive area configured to be touched by a second hand of the subject, ***where the ECG signal is extracted from the three conductive areas by using the signal of one conductive area as a reference and amplifying the differential voltage***

> ***between the other two conductive areas***, and where the processor is operative to continuously convert the ECG signal to form medical information.

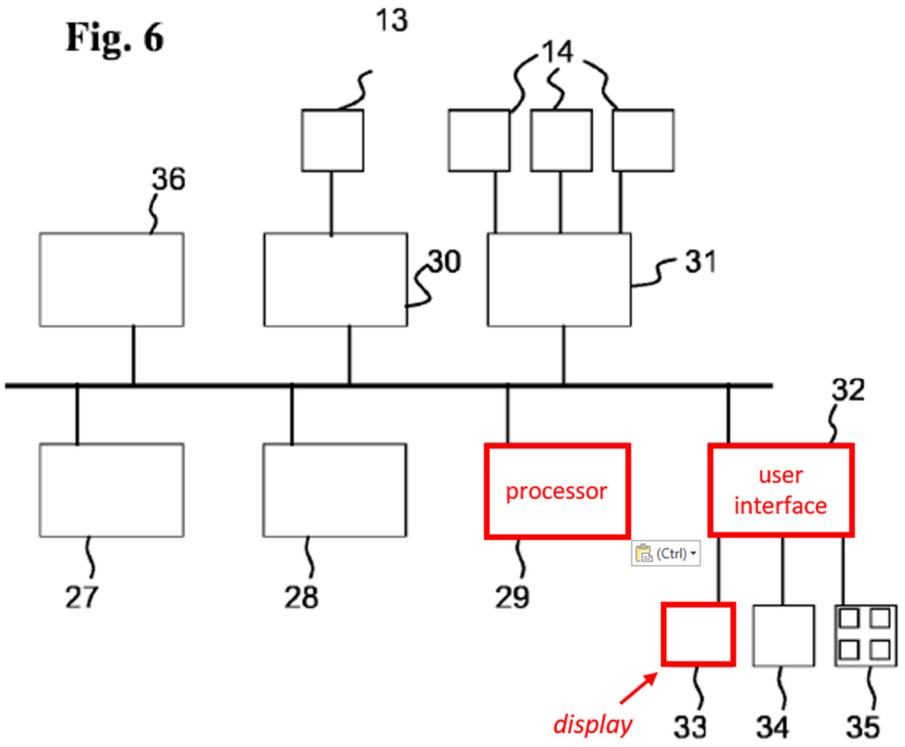
APPLE-1004, 5:6-20.

86. A POSITA would have understood that Shmueli's device includes an ECG sensor operatively coupled to the processing device and that the ECG sensor has three ECG electrodes because it has "an ECG measuring unit 31 with three ECG contact sensors 14" under the control of processor 29. Thus, Shmueli renders obvious [1.3].

[1.4] a display operatively coupled to the processing device; and

87. It is my opinion that Shmueli renders obvious element [1.4].

88. As shown in Fig. 6 below, Shmueli's heart monitoring device includes "a memory unit 28, a processor 29, an oximetry measuring unit 30 with the oximetry sensor 13, an ECG measuring unit 31 with three ECG contact sensors 14, **a user interface unit 32 preferably containing output devices such as a display 33**." APPLE-1004, 11:10-15.



APPLE-1004, Fig. 6 (annotated).

89. Shmueli further discloses that "[t]he notifications to the user, such as the various notifications to start the ECG measurement (element 42), notifications of ongoing ECG measurement (element 47), and notification that the ECG measurement has stopped (element 53) may be ***visual*** and/or audible, and/or ***graphic***, and/or ***textual***, and/or using sound, and/or using speech, and/or using vibration, etc." APPLE-1004, 14:4-8.

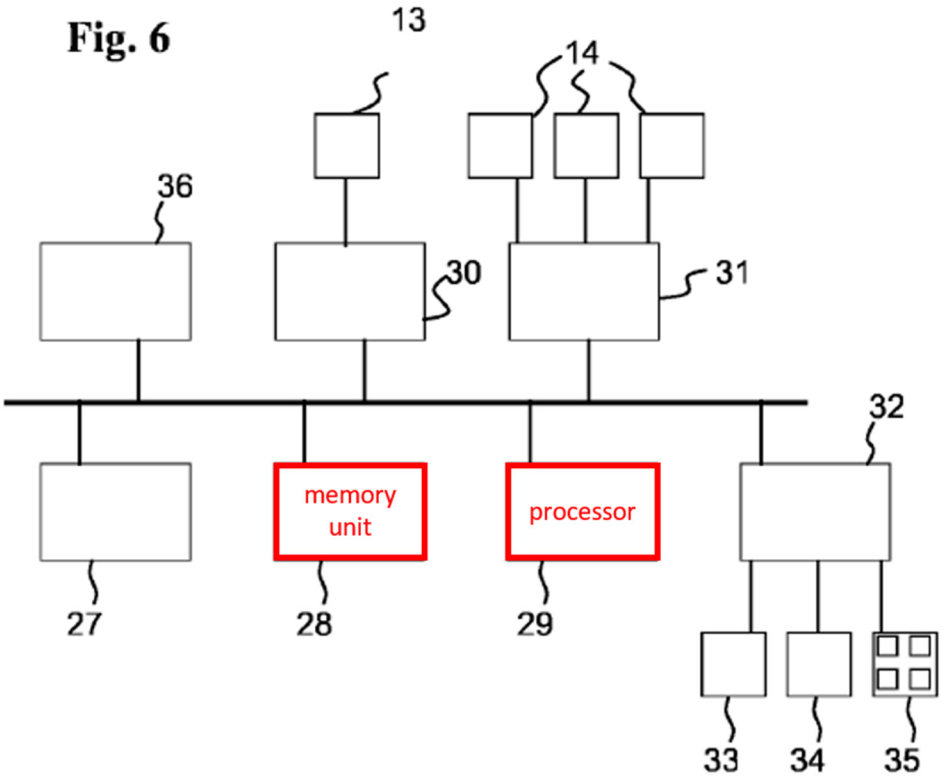
90. A POSITA would have understood that Shmueli's device includes a display operatively coupled to the processing device because it has "a user interface unit 32 preferably containing output devices such as a display 33" that is

coupled to processor 29. Thus, Shmueli renders obvious [1.4].

[1.5] a memory, operatively coupled to the processing device, the memory having instructions stored thereon that, when executed by the processing device, cause the processing device to:

91. It is my opinion that Shmueli renders obvious element [1.5].

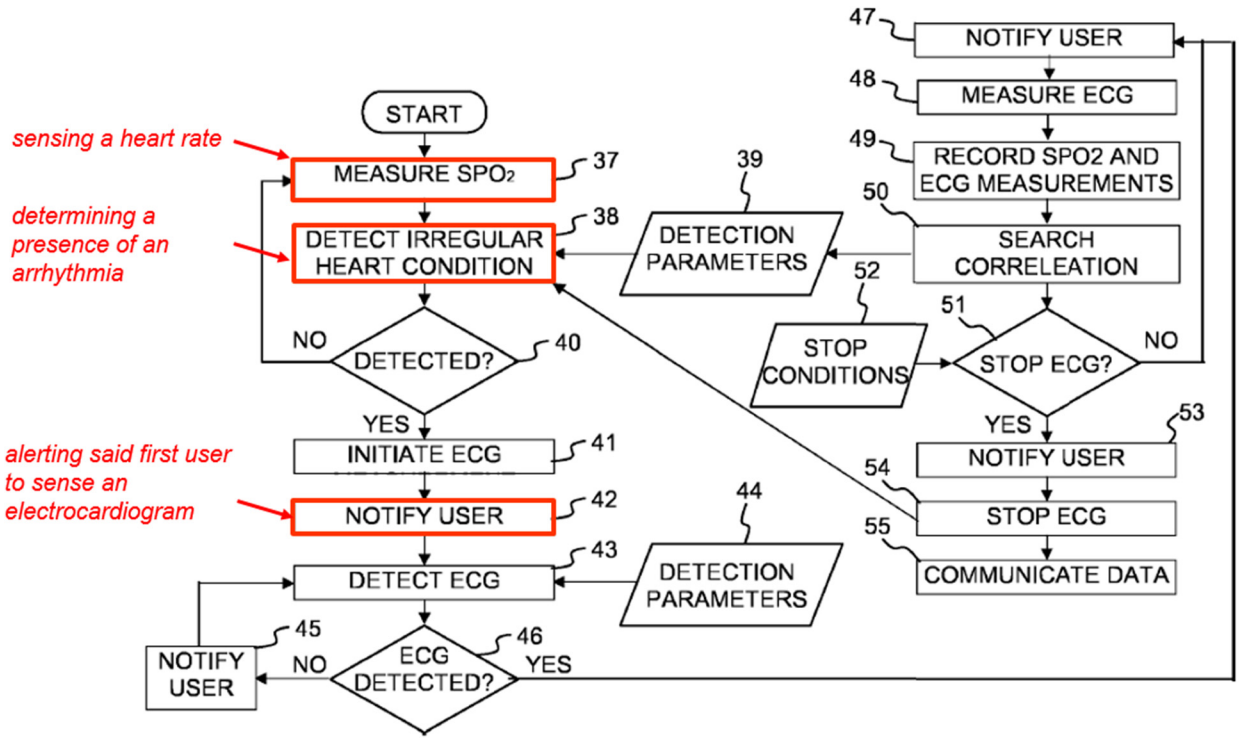
92. As shown in Fig. 6 below, Shmueli's heart monitoring device includes "**a memory unit 28**, a processor 29, an oximetry measuring unit 30 with the oximetry sensor 13, an ECG measuring unit 31 with three ECG contact sensors 14." APPLE-1004, 11:10-15. Shmueli further discloses "[t]he **memory unit 28 preferably contains software program containing instructions to be executed by the processor 29**." APPLE-1004, 11:19-21.



APPLE-1004, Fig. 6 (annotated).

93. Shmueli further discloses in Fig. 7 a flow chart of a software program executed by the processor 29 of the wrist-mounted monitoring device. APPLE-1004, 12:6-8 ("Reference is now made to Fig. 7, which is a simplified flow chart of a software program preferably executed by the processor 29 of the wrist-mounted heart monitoring device according to a preferred embodiment and the present invention.") and Fig. 7.

Fig. 7



APPLE-1004, Fig. 7 (annotated).

94. A POSITA would have understood that Shmueli's device includes a memory operatively coupled to the processing device and that the memory has instructions to be executed by the processing device because it has "a memory unit

28" that is coupled to processor 29 and that "memory unit 28 preferably **contains software program containing instructions to be executed by the processor 29**." Thus, Shmueli renders obvious [1.5].

[1.6] receive PPG data from the PPG sensor;

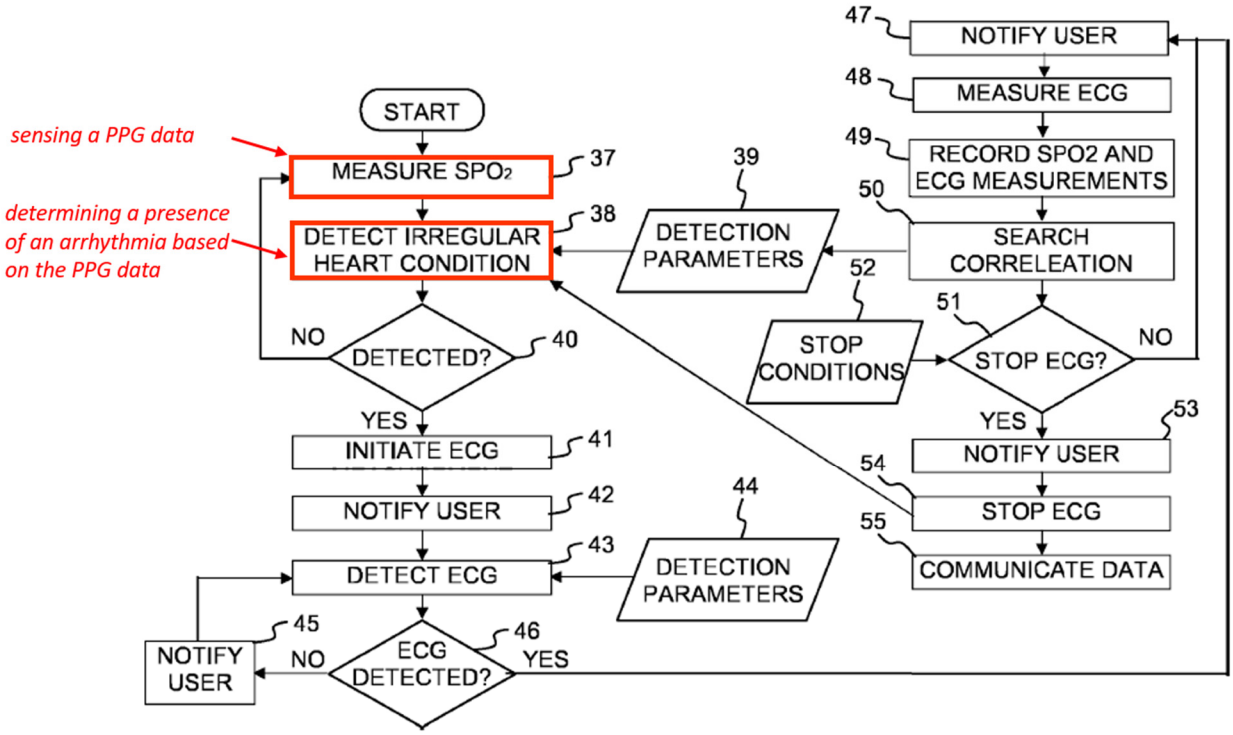
95. It is my opinion that Shmueli renders obvious element [1.6].

96. Shmueli discloses that "the software program contained in memory unit 28 preferably contains various procedures such as: Procedures for operating the oximetry measuring unit 30 and ECG measuring unit 31 including **procedures to continuously measure SpO2 signal**, and procedures to initiate ECG measurements. Procedures for operating the user-interface unit 32 and for interacting with the user including procedures for notifying the subject to perform an ECG measurement. **Procedures for analyzing oximetry measurements to detect various irregular heart conditions**." APPLE-1004, 11:22-31. Shmueli also explains that the terms SpO2, oximetry and photoplethysmography (PPG) have the same meaning. APPLE-1004, 7:25-27.

97. Fig. 7 of Shmueli provides a flow chart of a software program executed by Shmueli's processing device. APPLE-1004, 12:6-8. As shown in Fig. 7, the software program "starts in element 37 by measuring SpO2" and then "**proceeds to element 38 to derive from the SpO2 measurement physiological parameters**" and "scans the derived physiological parameters to detect various

irregularities of the heart condition." APPLE-1004, 12:9-17. As discussed above for element [1.0], a POSITA would have found it obvious that the term "irregular heart condition" in Fig. 7 refers to arrhythmia.

Fig. 7

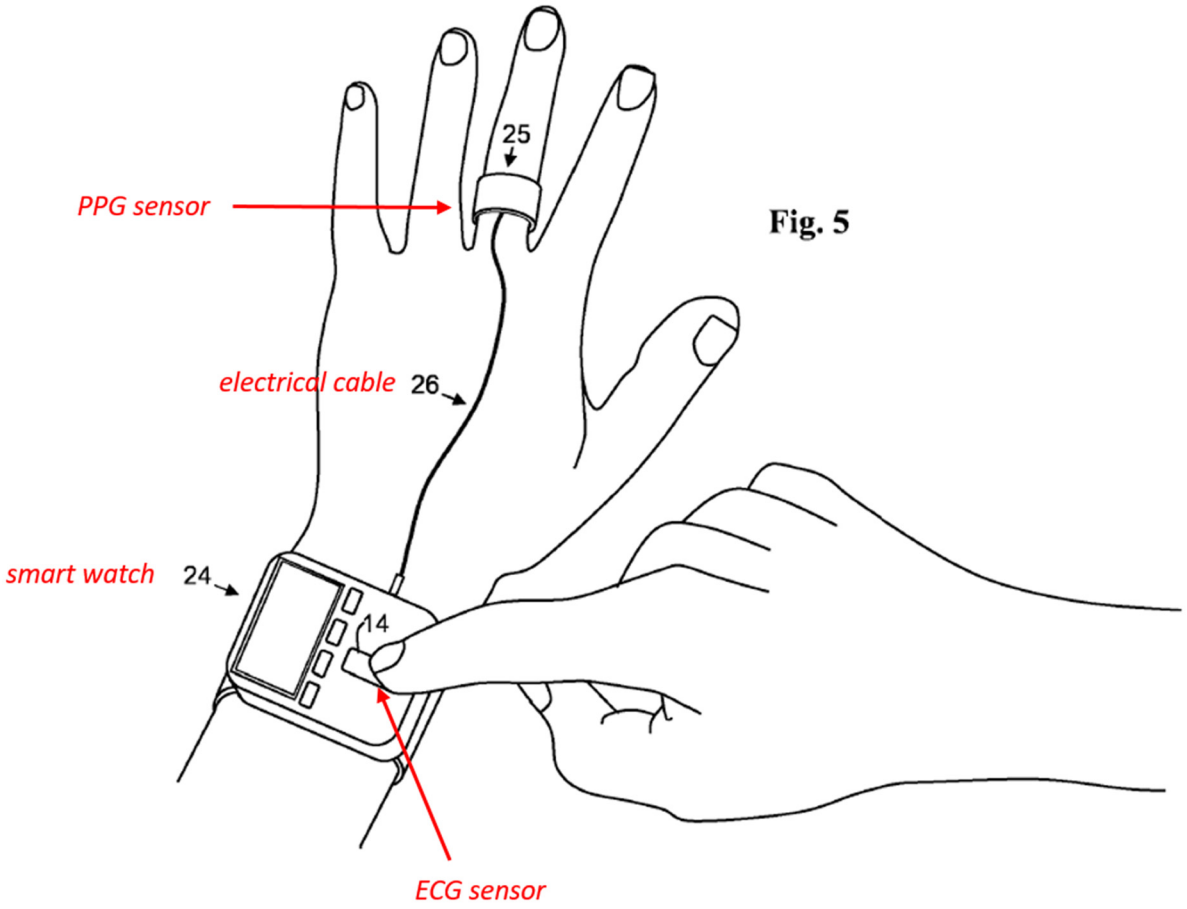


APPLE-1004, Fig. 7 (annotated).

98. A POSITA would have understood that the software causes the processing device to receive PPG data from the PPG sensor because element 38 requires the processor to "derive from the SpO2 measurement physiological parameters" and to scan "the derived physiological parameters to detect various irregularities of the heart condition." APPLE-1004, 12:9-17.

99. Shmueli further discloses that the oximetry (PPG) measuring unit can

be mounted on the inner side of a ring or a clip worn on a finger of the hand wearing the heart monitoring device. APPLE-1004, 9:20-22. As shown in Fig. 5 below, the PPG measuring unit (i.e., heart rate sensor) is connected to Shmueli's wrist-worn device through an electrical cable 26. APPLE-1004, 10:28-11:2 ("As seen, the wrist-mounted heart monitoring device 24 of Fig. 5 includes the oximeter (not shown) mounted inside a ring 25 warn on a finger of the hand wearing the heart monitoring device 24. ***The oximeter in the ring 24 is preferably connected to the heart monitoring device 24, preferably by an electrical cable 26***.") and Fig. 5. A POSITA would have understood that Shmueli's device is configured to receive PPG data from the oximetry (PPG) sensor through the electrical cable 26.



APPLE-1004, Fig. 5 (annotated).

100. For the reasons discussed above, it is obvious that the processor is configured to receive PPG data from the PPG sensor. Thus, Shmueli renders obvious [1.6].

[1.7] detect, based on the PPG data, the presence of an arrhythmia;

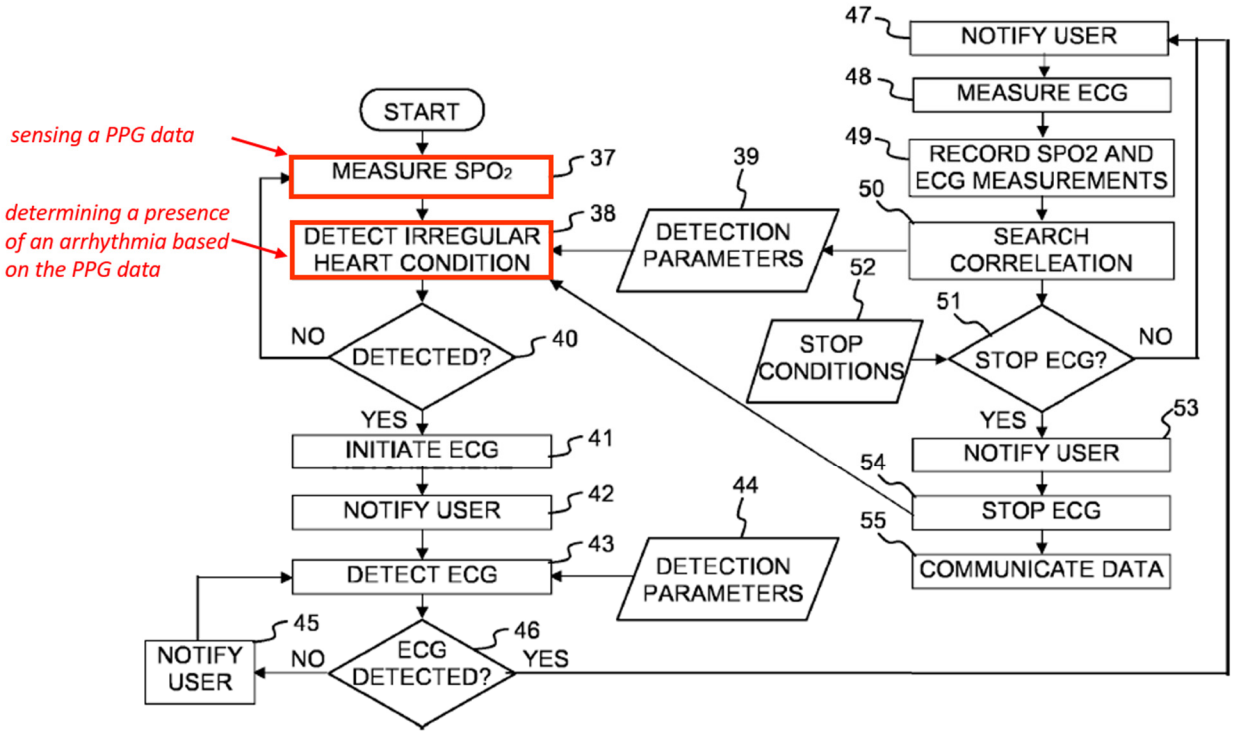
101. It is my opinion that Shmueli renders obvious element [1.7].

102. Shmueli discloses that "the software program contained in memory unit 28 preferably contains various procedures such as: Procedures for operating the oximetry measuring unit 30 and ECG measuring unit 31 including procedures

to continuously measure SpO2 signal, and procedures to initiate ECG measurements. Procedures for operating the user-interface unit 32 and for interacting with the user including procedures for notifying the subject to perform an ECG measurement. **Procedures for analyzing oximetry measurements to detect various irregular heart conditions**." APPLE-1004, 11:22-31. Shmueli also explains that the terms SpO2, oximetry and photoplethysmography (PPG) have the same meaning. APPLE-1004, 7:25-27.

103. Fig. 7 of Shmueli provides a flow chart of a software program executed by Shmueli's processing device. APPLE-1004, 12:6-8. As shown in Fig. 7, the software program "starts in element 37 by measuring SpO2" and then "**proceeds to element 38 to derive from the SpO2 measurement physiological parameters"** and **"scans the derived physiological parameters to detect various irregularities of the heart condition.**" APPLE-1004, 12:9-17.

Fig. 7



APPLE-1004, Fig. 7 (annotated).

104. As discussed above for element [1.0], although Shmueli does not explicitly use the term arrhythmia, a POSITA would have found it obvious that the term "irregular heart condition" in element 38 of Fig. 7 refers to arrhythmia. Thus, the software program at element 38 causes the processing device to detect, based on the PPG data, the presence of arrhythmia. APPLE-1004, Fig. 7. Indeed, it was well-known that PPG data can be used to detect arrhythmia. APPLE-1011, Abstract; APPLE-1016, Abstract ("We developed an arrhythmic pulse detection algorithm from photoplethysmography (PPG) measured in daily life using a wearable PPG sensor, in order to provide a simpler device than a Holter

electrocardiograph (ECG)."); APPLE-1020, Abstract ("The arrhythmia detecting apparatus of the present invention is provided with a pulse wave detecting means which non-invasively detects the pulse waveform, and an arrhythmia detecting means which detects arrhythmia by monitoring changes in the pulse waveform detected by the pulse wave detecting means."). Thus, Shmueli renders obvious [1.7].

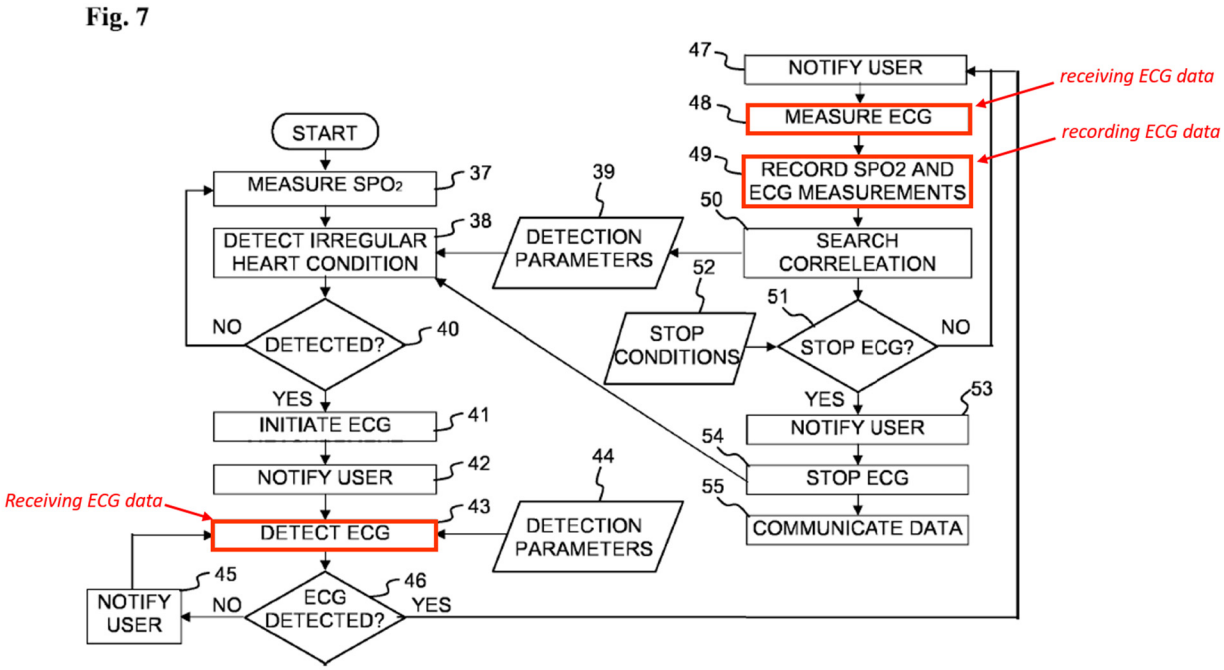
[1.8] receive ECG data from the ECG sensor; and

105. It is my opinion that Shmueli renders obvious element [1.8].

106. Shmueli discloses that "the software program contained in memory unit 28 preferably contains various procedures such as: Procedures for operating the oximetry measuring unit 30 and ECG measuring unit 31 including procedures to continuously measure SpO2 signal, and **procedures to initiate ECG measurements**" and "**procedure for identifying correlations between SpO2 measurement and ECG measurement of a particular subject to detect user-specific irregular heart conditions**." APPLE-1004, 11:22-31.

107. Fig. 7 of Shmueli provides a flow chart of a software program executed by Shmueli's processing device. APPLE-1004, 12:6-8. As shown in Fig. 7, the software program "starts in element 37 by measuring SpO2" and then "proceeds to element 38 to derive from the SpO2 measurement physiological parameters" and "scans the derived physiological parameters to detect various

irregularities of the heart condition.” APPLE-1004, 12:9-17. Then, the software program “initiates ECG measurement, preferably by operating ECG measuring unit 31” and “**proceeds to element 43 to detect and [sic] ECG signal**.” APPLE-1004, 12:23-28. Next, the software program “**proceeds to element 48 to perform the ECG measurement and to element 49 to record the SpO2 and the ECG measurements and store them in the memory unit 28**.” APPLE-1004, 13:10-12.



APPLE-1004, Fig. 7 (annotated).

108. A POSITA would have understood that the software causes the processing device to receive ECG data from the ECG sensor at various steps including element 43, element 48, and element 49. Thus, Shmueli renders obvious [1.7].

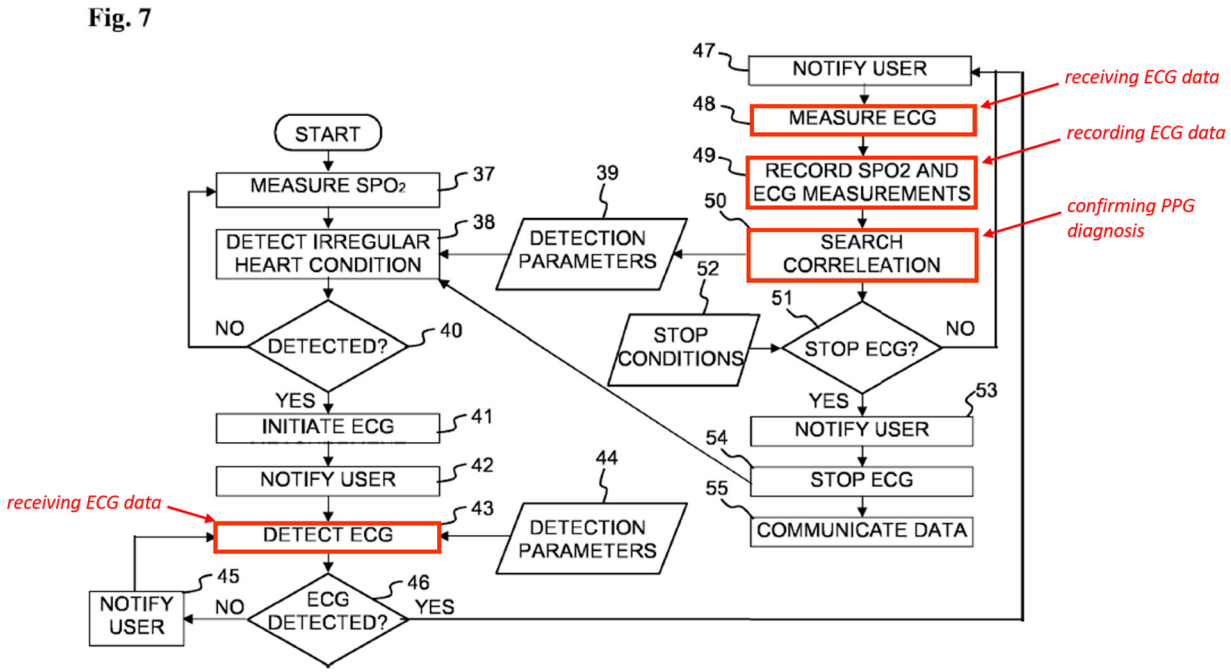
[1.9] confirm the presence of the arrhythmia based on the ECG data.

109. It is my opinion that Shmueli renders obvious element [1.9].

110. Shmueli discloses that "the software program contained in memory unit 28 preferably contains various procedures such as: Procedures for operating the oximetry measuring unit 30 and ECG measuring unit 31 including procedures to continuously measure SpO2 signal, and procedures to initiate ECG measurements" and "**procedure for identifying correlations between SpO2 measurement and ECG measurement of a particular subject to detect user-specific irregular heart conditions**." APPLE-1004, 11:22-31.

111. Fig. 7 of Shmueli provides a flow chart of a software program executed by Shmueli's device. APPLE-1004, 12:6-8. As shown in Fig. 7, the software program "starts in element 37 by measuring SpO2" and then "proceeds to element 38 to derive from the SpO2 measurement physiological parameters" and "scans the derived physiological parameters to detect various irregularities of the heart condition." APPLE-1004, 12:9-17. Then, the software program "initiates ECG measurement, preferably by operating ECG measuring unit 31" and "proceeds to element 43 to detect and [sic] ECG signal." APPLE-1004, 12:23-28. Next, the software program "proceeds to element 48 to perform the ECG measurement and to element 49 to record the SpO2 and the ECG measurements and store them in the memory unit 28." APPLE-1004, 13:10-12. The software

program also proceeds to element 50 to search for **correlations between the SpO2 signal and the ECG signal** to produce new detection parameters, or modify existing parameters, so as to **enhance the detection algorithms of the irregular heart conditions**. APPLE-1004, 13:16-19.



APPLE-1004, Fig. 7 (annotated).

112. As discussed above for element [1.0], although Shmueli does not explicitly use the term arrhythmia, a POSITA would have found it obvious that the term "irregular heart condition" in element 38 of Fig. 7 refers to arrhythmias. As discussed above for element [1.6], a POSITA would have found it obvious that the software at element 38 causes the processing device to detect, based on the PPG data, the presence of arrhythmia. Thus, a POSITA would have understood that the software at element 50, element 39 and element 38 causes the processing device to

confirm the presence of the arrhythmia based on the ECG data, by searching for correlations between the PPG and ECG data, modifying detection parameters, and confirming the presence of arrhythmia. An irregular heart condition is not a standard term in medicine. If you google the term, the first page only refers to arrhythmias. A POSITA would assume that when this term is used in the patent, it is referring to a cardiac arrhythmia. Arrhythmia is one of the most obvious (if not the most obvious) types of "irregular heart condition[s]" that can be determined using both PPG and ECG data. For example, both Amano and Lee 2013 disclose using PPG data to detect arrhythmia. APPLE-1011, Abstract; APPLE-1020, Abstract. Tran also discloses detecting arrhythmia using ECG data. APPLE-1007, [0479]. Li 2012 discloses detecting arrhythmia using both PPG and ECG data. APPLE-1006, Abstract. Suzuki 2009 explains that, while arrhythmia is traditionally detected using ECG, it can also be detected using PPG data. APPLE-1016, 6080. Other references explain that arrhythmia can be detected using HRV, which in turn can be derived from either PPG or ECG data. *See* APPLE-1012 (explaining detecting arrhythmia based on HRV derived from ECG data); APPLE-1013, Abstract ("Our results demonstrate that the parameters of PPGV are highly correlated with the parameters of HRV."); APPLE-1014, Abstract ("HRV can also be reliably estimated from the PPG based PP interval method."); APPLE-1015, Abstract ("Our results confirm that PPG provides accurate interpulse intervals

from which HRV measures can be accurately derived in healthy subjects under ideal conditions, suggesting this technique may prove a practical alternative to ECG for HRV analysis.") and APPLE-1018, Abstract (replacing ECG with PPG to detect HRV). Thus, based on Shmueli's disclosure and the general knowledge of a POSITA, a POSITA would have understood that the software at element 50, element 39 and element 38 causes the processing device to confirm the presence of the arrhythmia based on the ECG data, by searching for correlations between the PPG and ECG data, modifying detection parameters, and confirming the presence of arrhythmia. Thus, Shmueli renders obvious [1.9].

113. In addition, after the software confirms the detected arrhythmia at element 50, element 39 and element 38 by searching for correlations between the PPG and ECG data, the software proceeds to element 51 to determine a set of stop conditions (element 52), such as whether "***the irregular heart condition has stopped.***" APPLE-1004, 13:22-29. Shmueli discloses that when the software program detects that "***the irregular heart condition has stopped***" (element 51), the software program notifies the user that the ECG measurement has stopped (element 53) and stops the ECG measurement (element 54). APPLE-1004, 13:22-29. A POSITA would have understood that determining whether "the irregular heart condition has stopped" also requires the software program to confirm the presence of arrhythmia using the ECG data.

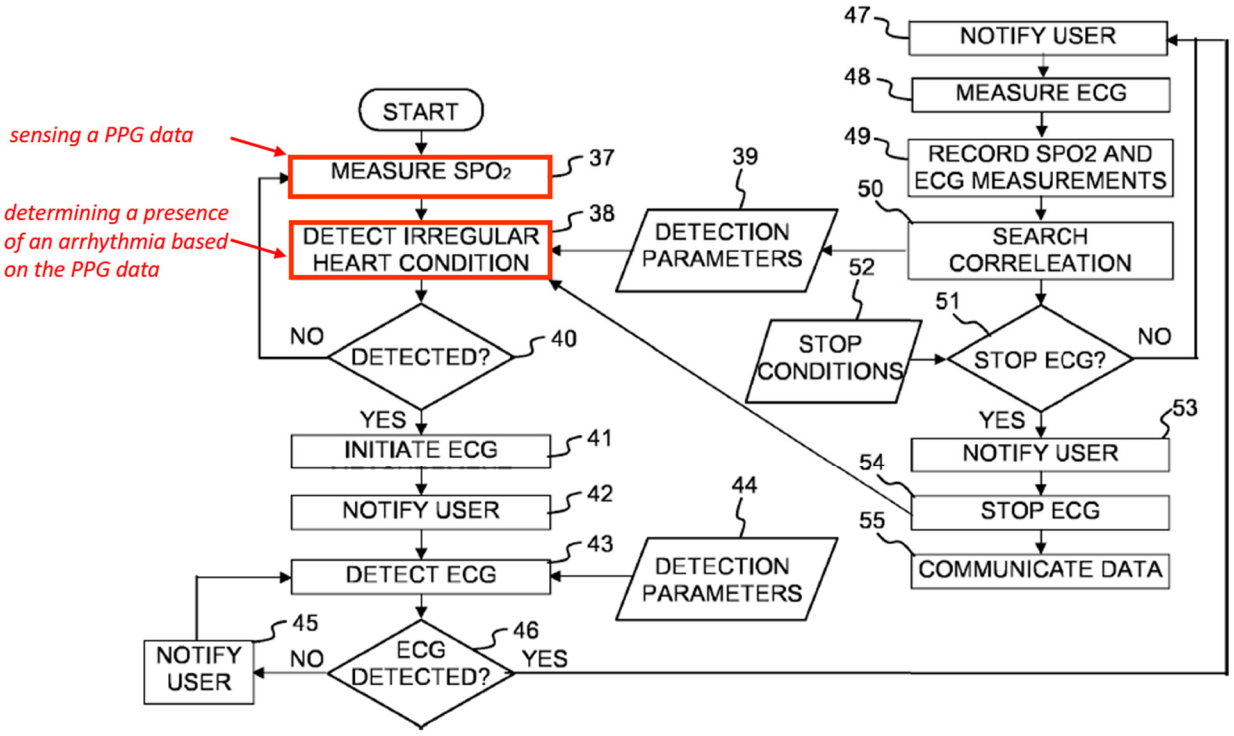
B. Claim 7

[7.0] The smart watch of claim 1, wherein the processing device is further configured to: extract one or more features from the PPG data; and detect, based on the one or more features, the presence of the arrhythmia.

114. It is my opinion that Shmueli renders obvious element [7.0].

115. Shmueli teaches "continuously measuring **SpO_2** at the wrist of the user, detecting an **irregular heart condition** from the SpO_2 measurement." APPLE-1004, Abstract. As discussed in element [1.0], a POSITA would have understood the term "irregular heart condition" refers to and includes arrhythmias. Like the '731 patent, Shmueli's device first detects arrhythmia based on SpO2 measurement, which is also known as photoplethysmography ("PPG") or pulse oximetry. APPLE-1004, Abstract and 7:25-31. As shown in Fig. 7 below, Shmueli's software program "starts in element 37 by measuring SpO2" and then "proceeds to element 38 to derive from the SpO2 measurement **physiological parameters such as pulse rate**, pulse amplitude, pulse shape, rate of blood flow, etc." and "to detect various irregularities of the heart condition." APPLE-1004, 12:9-17.

Fig. 7



APPLE-1004, Fig. 7 (annotated).

116. As discussed above for element [1.7], a POSITA would have found it obvious that the software at element 38 causes the processing device to detect, based on the PPG data, the presence of arrhythmia. A POSITA would have found it obvious that a determination of arrhythmia based on PPG data involves extracting from the PPG data certain features, such as pulse rate, RR intervals and HRV. By the Critical Date, it was well-known that RR intervals and HRV can be extracted from either PPG data or the ECG data. *See* APPLE-1012 (explaining detecting arrhythmia based on HRV derived from ECG data); APPLE-1013, Abstract ("Our results demonstrate that the parameters of PPGV are highly

correlated with the parameters of HRV."); APPLE-1014, Abstract ("HRV can also be reliably estimated from the PPG based PP interval method."); APPLE-1015, Abstract ("Our results confirm that PPG provides accurate interpulse intervals from which HRV measures can be accurately derived in healthy subjects under ideal conditions, suggesting this technique may prove a practical alternative to ECG for HRV analysis.") and APPLE-1018, Abstract (replacing ECG with PPG to detect HRV). This is because under normal conditions, the electrical impulse of the heart (ECG) stimulates a cardiac contraction resulting in a spread of the pulsatile wave (PPG) of blood to the periphery. APPLE-1014, p. 480. Many studies verify the high correlation between RR intervals (RRI) obtained from ECG and PP intervals (PPI) obtained from PPG. APPLE-1025, p. 16; APPLE-1018, Fig. 1. In addition, a POSITA would have been motivated to extract HRV from the PPG data because, although certain types of arrhythmias (e.g., tachycardia or bradycardia) can be detected by absolute heart rate values, diagnosis of other types of arrhythmias (e.g., atrial fibrillation, one of the most common cardiac arrhythmia) requires HRV analysis. In addition, HRV analysis is more robust because it involves extracting the RR intervals and is less affected by noise. APPLE-1039, p. 52 ("This is a more robust method since the R-R time intervals are less affected by the noise.").

117. In addition, by the Critical Date, machine learning algorithms were

the mainstream technique to detect arrhythmia based on various features (e.g., HRV) extracted from the heart rate data. APPLE-1040, p. 1928 (discussing neural networks, wavelet transforms, support vector machines, fuzzy logic and rule-based algorithms) and APPLE-1041, p. 74 (discussing fuzzy logic and neural networks). A POSITA would have understood that these machine learning algorithms involve extracting features from the underlying data. For example, Li 2012 discloses detecting arrhythmia using neural networks based on features extracted from PPG data. APPLE-1006, Abstract. In addition, Tsipouras 2004 discloses detecting arrhythmia using machine learning based on HRV features. APPLE-1012, Abstract.

118. Thus, although Shmueli does not specifically disclose how to detect arrhythmia based on PPG data, a POSITA would have found it obvious to extract certain features (e.g., RR intervals and HRV) from the PPG data and to determine arrhythmia based on these features.

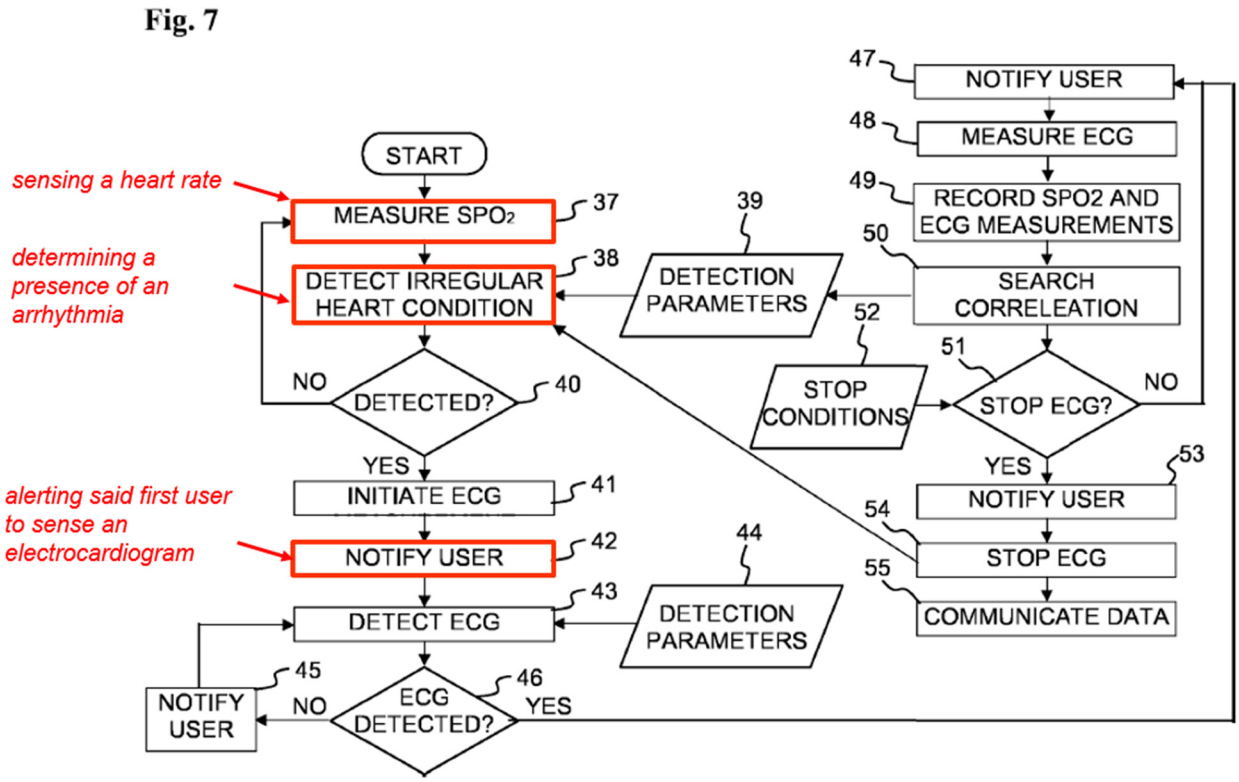
C. Claim 12

[12.0] The smart watch of claim 1, wherein the processing device is further configured to generate a notification of the detected arrhythmia.

119. It is my opinion that Shmueli renders obvious element [12.0].

120. As discussed above in Section X.A, Shmueli's method first detects arrhythmia based on the SpO2 measurement, which is also known as PPG or pulse oximetry. APPLE-1004, Abstract. If the SpO2 measurement indicates an irregular

heart condition, Shmueli's method then notifies the user to take an ECG measurement to confirm the diagnosis. *Id*. Fig. 7 is an example of Shmueli's method:



APPLE-1004, Fig. 7 (annotated).

121. As Fig. 7 shows, Shmueli's method measures SpO2 (element 37) and detects an irregular heart condition based on the PPG data (element 38). APPLE-1004, Fig. 7 and 12:6-30. If an irregular heart condition is detected (element 40), the device initiates ECG measurement (element 41) and notifies the user to perform an ECG measurement (element 42), preferably using the ECG monitoring device in Figs. 3 and 4. *Id.* ("The software program preferably proceeds to element 42 to notify the user to perform an ECG measurement, preferably making use of

the ECG monitoring device as described and illustrated with reference to Figs. 3 and 4").

122. As discussed for element [1.4], Shmueli's device includes a display operatively coupled to the processing device. Shmueli's "processor is operative to detect an irregular heart condition from the SpO2 measurement, **to notify the subject to perform an ECG measurement upon detecting the irregular heart condition**, and to initiate the ECG measurement." APPLE-1004, 4:6-9. Shmueli also discloses that such a notification may be visual, audible, graphic, textual, etc. APPLE-1004, 14:4-8. It would have been obvious that Shmueli's processing device (processor 29) (APPLE-1004, Figure 6) is configured to generate a notification of the detected arrhythmia to notify the subject to perform an ECG. From Shmueli's disclosure, a POSITA would have found it beneficial to notify the user of the detected arrhythmia because it allows the user to make an informed decision on whether to perform an ECG based on the PPG data. Thus, Shmueli renders obvious [12.0].

123. In addition, as shown in Fig. 7, after the ECG is detected (elements 48 and 49), Shmueli's method "proceeds to element 50 to search for correlations between the SpO2 signal and the ECG signal to produce new detection parameters, or modify existing detection parameters, so as to enhance the detection algorithm of the irregular heart conditions." APPLE-1004, 13:16-19. Based on this

disclosure, it would have been obvious that Shmueli's device (processor 29) is configured to confirm the initial diagnosis based on the ECG and PPG data and to generate a notification of the confirmed arrhythmia. A POSITA would have found it beneficial to notify the user of the confirmed arrhythmia because it allows the user to make an informed decision on whether there is a need to seek medical help. Thus, Shmueli renders obvious generating both a notification of the initially detected arrhythmia based on PPG data and a second notification of the confirmed arrhythmia based on the PPG and ECG data. Thus, Shmueli renders obvious [12.0].

D. Claim 13

[13.0] The smart watch of claim 1, further comprising a biometric data sensor, wherein the processing device is further configured to: receive biometric data of the user from the biometric data sensor; and detect, based on the biometric data, the presence of the arrhythmia.

124. It is my opinion that Shmueli renders obvious element [13.0].

125. The '731 patent generally describes the biometric data sensor as including "a hand-held **electrocardiogram (ECG) sensor**, a wrist-worn activity sensor, a blood pressure monitor, a personal weighing scale, a body fat percentage sensor, a personal thermometer, **a pulse oximeter sensor**, or any mobile health monitor or sensor." APPLE-1001, 4:57-61. Shmueli discloses that the terms "oxygen saturation in the blood," "blood oxygen saturation," "pulse oximeter," oximetry, Sp02, and photoplethysmography have the same meaning and may be

used interchangeably. APPLE-1004, 7:25-31. Thus, a POSITA would have understood that Shmueli's PPG sensor, also known as a pulse oximeter sensor, is a biometric data sensor within the meaning of the '731 patent. Similarly, the PPG data from the PPG sensor is a biometric data within the meaning of the '731 patent.

126. As discussed for element [1.2], element [1.6] and element [1.7], Shmueli's device receives PPG data from the PPG sensor and detects, based on the PPG data, the presence of an arrhythmia. Thus, Shmueli renders obvious [13.0].

127. In addition, based on the '731 patent's explanation that an ECG sensor is also a biometric data sensor, a POSITA would have understood that Shmueli's ECG sensor is a biometric data sensor within the meaning of the '731 patent. APPLE-1001, 4:57-61 ("The sensor may comprise one or more of a hand-held **electrocardiogram (ECG) sensor**, a wrist-worn activity sensor, a blood pressure monitor, a personal weighing scale, a body fat percentage sensor, a personal thermometer, **a pulse oximeter sensor**, or any mobile health monitor or sensor."). Similarly, the ECG data from the ECG sensor is a biometric data within the meaning of the '731 patent.

128. As discussed above in element [1.3], element [1.8], and element [1.9], Shmueli's device receives ECG data from the ECG sensor and confirms, based on the ECG sensor, the presence of an arrhythmia. Thus, for this additional reason, Shmueli renders obvious [13.0].

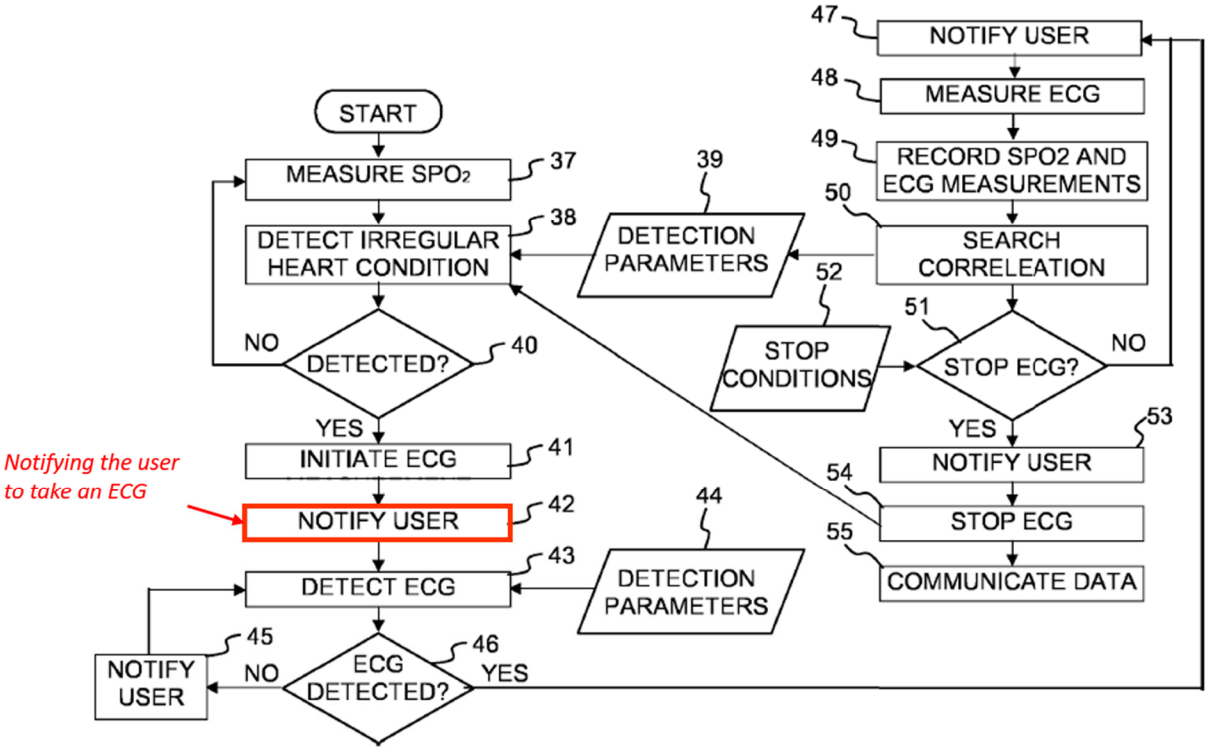
E. Claim 16

[16.0] The smart watch of claim 1, the processing device further to receive the ECG data from the ECG sensor in response to receiving an indication of a user action.

129. It is my opinion that Shmueli renders obvious element [16.0].

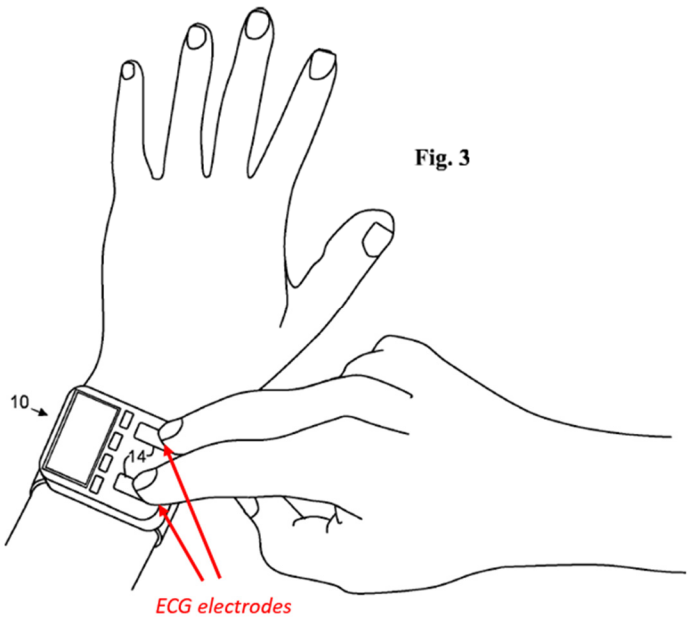
130. As discussed above in Section X.A, Shmueli's device first detects arrhythmia based on SpO2 measurement, which is also known as photoplethysmography ("PPG"). If the SpO2 measurement indicates arrhythmia, Shmueli's device then notifies the user to take an ECG measurement to confirm the arrhythmia detection. As discussed for element [1.8], Shmueli's processing device is configured to receive the ECG data from the ECG sensor. Fig. 7 shows an example of Shmueli's method:

Fig. 7



APPLE-1004, Fig. 7 (annotated).

131. A POSITA would have understood that the "notify user" step in element 42 requires the user to take an action to perform the ECG monitoring. Indeed, Shmueli discloses that the ECG measurement includes "contacting a first conductive area to at least a portion of the wrist, and a second conductive area to a finger of a **second hand** of the subject." APPLE-1004, 3:14-19. Fig. 3 of Shmueli shows an example of a user using Shmueli's device to take an ECG by touching the ECG sensors on the front of the device with a second hand.



APPLE-1004, Fig. 3 (annotated).

132. A POSITA would have understood that, in order to contact a second conductive area to a finger of a second hand of the subject, a user action (e.g., contacting with a second hand) is required. Thus, Shmueli renders obvious [16.0].

F. Claim 17

[17.0] A method to detect the presence of an arrhythmia of a user on a smart watch, comprising:

133. It is my opinion that Shmueli renders obvious element [17.0]. See [1.0].

[17.1] receiving PPG data from a PPG sensor of the smartwatch;

134. It is my opinion that Shmueli renders obvious element [17.1]. See [1.6].

[17.2] detecting by a processing device, based on the PPG data, the presence of an arrhythmia;

135. It is my opinion that Shmueli renders obvious element [17.2]. See [1.7].

[17.3] receiving ECG data from an ECG sensor of the smartwatch; and

136. It is my opinion that Shmueli renders obvious element [17.3]. See [1.8].

[17.4] confirming the presence of the arrhythmia based on the ECG data.

137. It is my opinion that Shmueli renders obvious element [17.4]. See [1.9].

G. Claim 23

[23.0] The method of claim 17, further comprising generating a notification of the detected arrhythmia.

138. It is my opinion that Shmueli renders obvious element [23.0]. See [12.0].

H. Claim 24

[24.0] The method of claim 17, further comprising receiving the ECG data from the ECG sensor in response to receiving an indication of a user action.

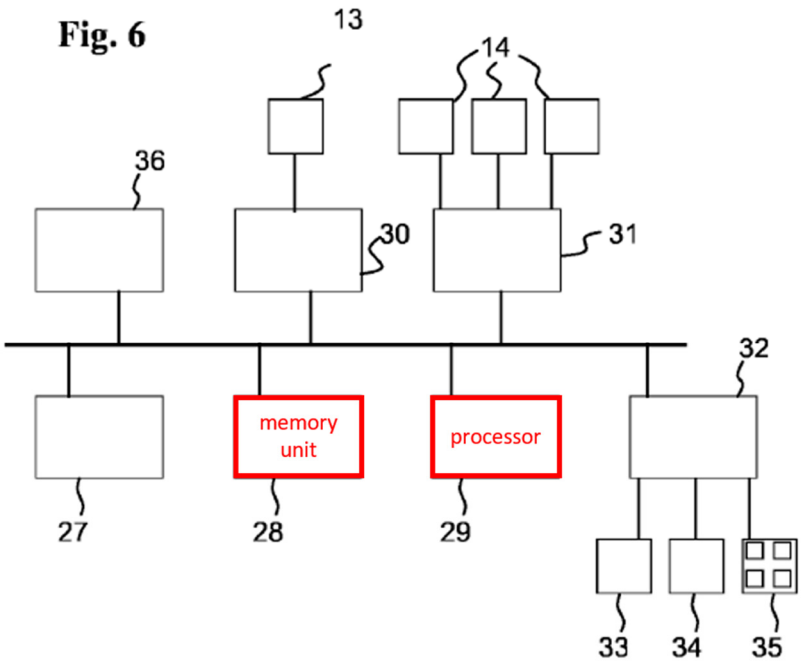
139. It is my opinion that Shmueli renders obvious element [24.0]. See [16.0].

I. Claim 25

[25.0] A non-transitory computer-readable storage medium including instructions that, when executed by a processing device, cause the processing device to:

140. It is my opinion that Shmueli renders obvious element [25.0].

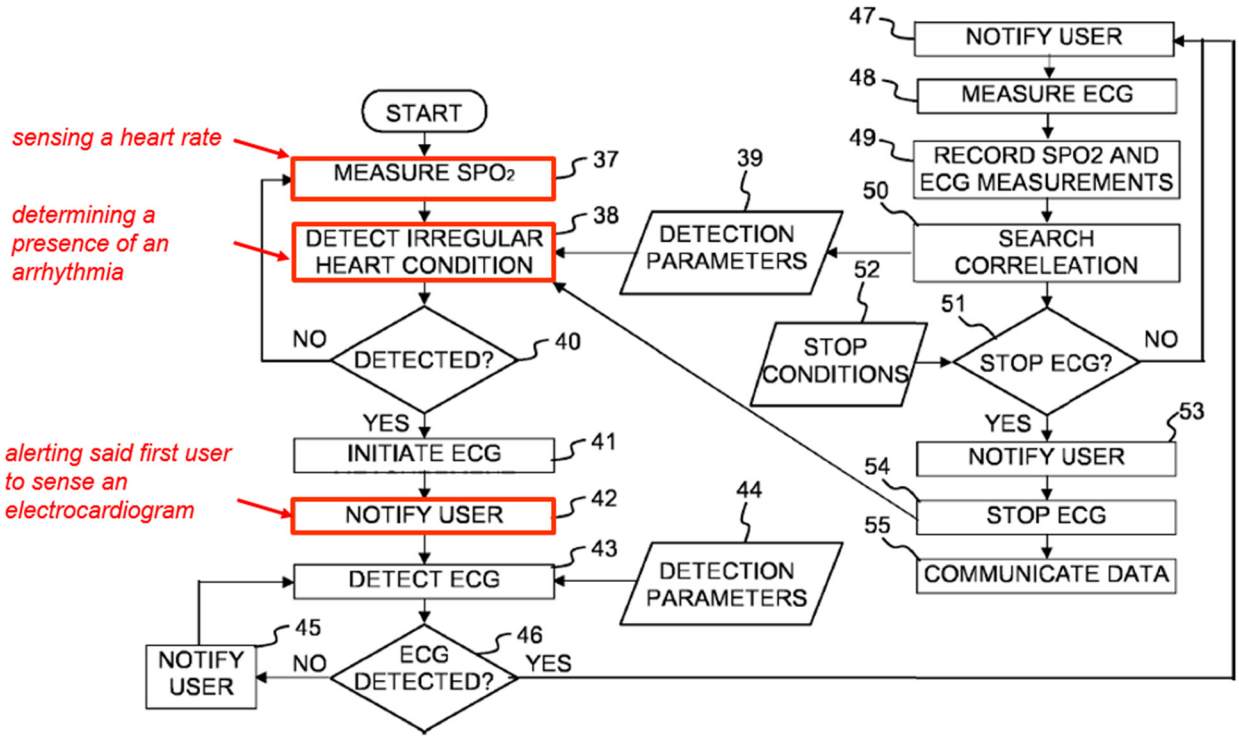
141. As shown in Fig. 6, Shmueli's heart monitoring device "includes a power supply unit such as a battery 27, **a memory unit 28**, a processor 29, an oximetry measuring unit 30 with the oximetry sensor 13, an ECG measuring unit 31 with three ECG contact sensors 14, a user interface unit 32 preferably containing output devices such as a display 33 and a sound producing device 34, and a user input device 35 for example including buttons, and optionally a communication unit 36." APPLE-1004, 11:10-15. Shmueli further discloses "[t]he **memory unit 28 preferably contains software program containing instructions to be executed by the processor 29**." APPLE-1004, 11:19-21.



APPLE-1004, Fig. 6 (annotated).

142. Shmueli further discloses in Fig. 7 a flow chart of a software program executed by the processor 29 of the wrist-mounted monitoring device. APPLE-1004, 12:6-8 ("Reference is now made to Fig. 7, which is a simplified flow chart of a software program preferably executed by the processor 29 of the wrist-mounted heart monitoring device according to a preferred embodiment and the present invention.") and Fig. 7.

Fig. 7



APPLE-1004, Fig. 7 (annotated).

143. A POSITA would have understood that Shmueli's memory 28 constitutes "a non-transitory computer-readable storage medium including instructions" to be executed by a processing device. Fig. 7 of Shmueli provides a flow chart of a software program contained in memory unit 28 and executed by processor 29. APPLE-1004, Figs. 6-7, 11:22-23 and 12:6-8. Thus, Shmueli renders obvious [25.0].

[25.1] receive PPG data from a PPG sensor of the smartwatch;

144. It is my opinion that Shmueli renders obvious element [25.1]. See element [1.6].

[25.2] detect by the processing device, based on the PPG data, the presence of an arrhythmia;

145. It is my opinion that Shmueli renders obvious element [25.2]. See element [1.7].

[25.3] receive ECG data from an ECG sensor of the smartwatch; and

146. It is my opinion that Shmueli renders obvious element [25.3]. See element [1.8].

[25.4] confirm the presence of the arrhythmia based on the ECG data.

147. It is my opinion that Shmueli renders obvious element [25.4]. See element [1.9].

J. Claim 26

[26.0] The non-transitory computer-readable storage medium of claim 25, wherein the processing device is further configured to: extract one or more features from the PPG data; and detect, based on the one or more features, the presence of the arrhythmia.

148. It is my opinion that Shmueli renders obvious element [26.0]. See element [7.0].

K. Claim 30

[30.0] The non-transitory computer-readable storage medium of claim 25, the processing device further to receive the ECG data from the ECG sensor in response to receiving an indication of a user action.

149. It is my opinion that Shmueli renders obvious element [30.0]. See element [16.0].

XII. ANALYSIS OF SHMUELI IN VIEW OF OSORIO

150. For the reasons articulated in detail below, and based on my review of the '731 patent, the file history, and the prior art references cited here, it is clear that a POSITA would have readily understood that the teachings of Shmueli in view of Osorio provide all the elements of claims 1, 2, 4, 7, 12-14, 16-18, 20, 23-26 and 30.

A. The Combination of Shmueli and Osorio

151. As discussed above, Shmueli's wrist-mounted heart monitoring device detects an irregular heart condition (arrhythmia) based on PPG and ECG measurements taken at a person's wrist. Though Shmueli's detection method does not expressly account for a user's activity level, it was well-known that activity level is related to HR and HRV and a POSITA would have found it obvious to improve Shmueli's method by considering activity level. APPLE-1005, [0029]; APPLE-1035, p. 303; APPLE-1050, p. S465. For example, as early as 1988, it was recognized that "variations in heart rate during exercise correlate with changes of exercise intensity." APPLE-1035, p. 303. In fact, based on this well-recognized correlation between heart rate and activity level, heart rate has been commonly employed as an objective method of assessing physical activity. APPLE-1050, p. S465. This is because heart rate is a physiological parameter known to have a strong positive association with energy expenditure during large muscle dynamic

exercise. *Id*. A POSITA would have been aware that the normal heart rate ranges from 60-100bpm, and that failure to account for physical activity or stress, that might elevate heart rates above 100 bpm during normal daily activity would result in triggered alerts from physiologic and not pathologic events that occur during normal daily activity. Indeed, Osorio explicitly describes the benefits (e.g., improved accuracy, reliability, and reduced false detection) of using activity level to detect an irregular heart condition. APPLE-1005, [0029], [0036]. With these benefits in mind, a POSITA would have been motivated to incorporate Osorio's activity sensor and activity level analysis techniques into Shmueli's heart monitoring device. APPLE-1005, [0029].

152. In implementing the Shmueli-Osorio device, a POSITA would have modified Shmueli's heart monitoring device to incorporate two types of teachings from Osorio—(i) using activity level monitoring to improve the accuracy of detecting a pathological event (e.g., arrhythmia), and (ii) determining HRV from HR and using HRV to detect the pathological event (e.g., arrhythmia). As discussed below, the combined Shmueli-Osorio device would have been advantageous for use in detecting pathological events.

(a) *Activity Level Monitoring*

153. A POSITA would have been motivated to modify Shmueli to incorporate Osorio's activity level monitoring to enable more sophisticated cardiac

monitoring that improves accuracy of detecting a pathological event (e.g., arrhythmia). For example, as discussed above, Osorio teaches that activity level information can be used to avoid "false diagnoses." APPLE-1005, [0029]. Osorio also recognizes that, "to determine (using body systems and their features) whether a body system is functioning pathologically or non-pathologically with a ***clinically worthwhile degree of accuracy and reliability***, one must take into account ***the type and/or level of activity being performed by a subject*** at the time the pathological/non-pathological determination is made." APPLE-1005, [0029]. As Osorio explains, "it is imperative to know whether or not ***a given increase in heart rate is associated with a change in activity*** (e.g., physical or emotional) and if such a change in activity is occurring, to determine if the heart rate increase is commensurate with said activity type and level." *Id*. In this regard, Osorio confirms that "***false negative and false positive detections*** of pathological events ***may be reduced*** by dynamically determining pathological or non-pathological ranges for particular body indices based on ***activity type and level***." *Id.*, [0036].

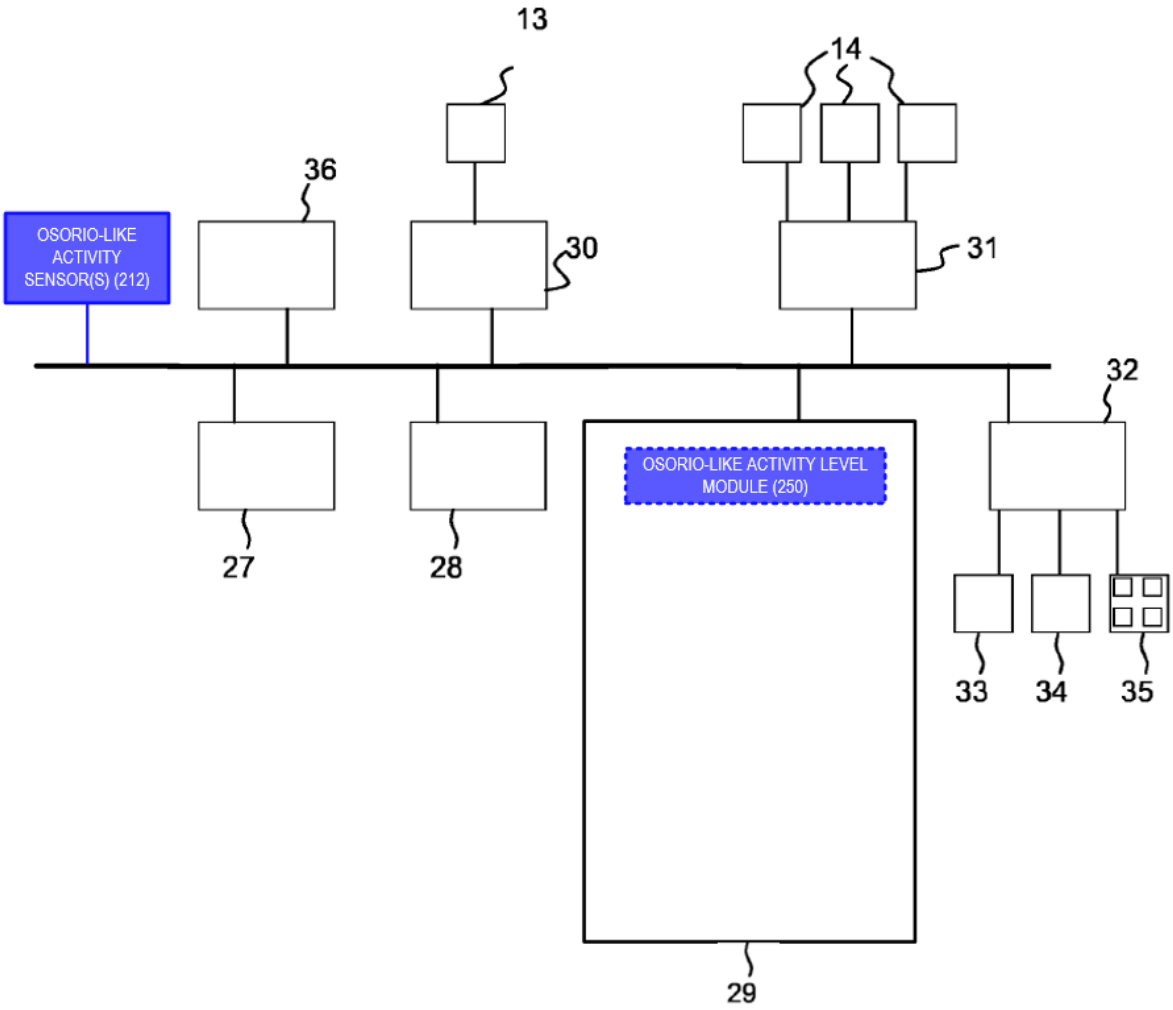
154. A POSITA would have found the modification of Shmueli's heart monitoring device to incorporate Osorio's activity level monitoring techniques to have been obvious since, by the Critical Date, it was well-known that activity level was related to HR and, therefore, activity level would have been considered an option for improving Shmueli's detection of irregular heart conditions. APPLE-

1005, [0029]; APPLE-1035, 303; APPLE-1050, S465. This is consistent with Shmueli's primary focus on enabling a convenient yet comfortable device to measure ECG only upon detection of an irregular heart condition using PPG data. APPLE-1004, 1:6-2:13.

155. To implement the modification discussed above, a POSITA would have incorporated the following teachings from Osorio into Shmueli's heart monitoring device: (a) hardware elements used for measuring activity level, such as Osorio's activity sensors 212 (e.g., motion sensors) and (b) software-related techniques for processing sensed data to determine an activity level of a patient, such as those performed by Osorio's activity level module 250.

156. A POSITA would have found it obvious to implement this modification in several ways, consistent with the disclosures of both references. For example, a POSITA would have found it obvious to modify Shmueli's heart monitoring device to include activity level sensors (similar to Osorio's activity sensors 212) that sense body signal data representing user activity. APPLE-1005, [0033]. A POSITA also would have found it obvious to configure processor 29 in Shmueli's heart monitoring device to execute operations related to activity level monitoring that are performed by Osorio's activity level module 250, such as determining activity level based on body signal data sensed by activity level sensors 212. *Id.*, [0034]. A visual representation of this modification is shown in

Shmueli's Figure 6 below (modification in blue):



Shmueli's Heart Monitoring Device (Modified To Incorporate Osorio's Activity Level Monitoring)

157. A POSITA would have had a reasonable expectation of success in modifying Shmueli's heart monitoring device based on Osorio in the manner shown above. Both Shmueli and Osorio are directed to detecting a pathological event (e.g., irregular heart condition, pathological condition, both of which include arrhythmia) based on sensed data (e.g., HR). APPLE-1004, Abstract; APPLE-

1005, Abstract. Shmueli's heart monitoring device uses an oximetry sensor for an initial diagnosis and an ECG sensor for confirmation. APPLE-1004, Abstract, 2:16-21, 11:22-13:21, Fig. 7. Osorio similarly teaches a monitoring device that tracks HR using a HR sensor. APPLE-1005, [0033], Fig. 1. In assessing Osorio's disclosure when reviewing Shmueli, a POSITA would have viewed Shmueli's heart monitoring device as a similar type of external or body-worn medical device described in Osorio. Accordingly, a POSITA would have viewed Osorio's activity level sensor 212 as being readily able to be incorporated into Shmueli's heart monitoring device.

158. Moreover, given the overlapping subject matter between Shmueli and Osorio, a POSITA would have expected the processing capabilities of Shmueli's processor 29 to able to perform (or be able to be upgraded with routine skill) to implement the operations performed by Osorio's software modules. APPLE-1031, [0001], [0028]-[0029], Figs. 1-2 (discussing processing data from multiple sensors including PPG, ECG, and motion sensors); APPLE-1032, 19:54-22:3, Fig. 8A (discussing processing data from multiple sensors including PPG, ECG, and motion sensors). For example, Sun discloses a system containing PPG, ECG and motion sensors to provide context-aware control of sensors and sensor data to monitor cardiovascular diseases. APPLE-1031, [0028]-[0029], [0034] (describing sensors including accelerometer, ECG sensor, and PPG sensor) and Figs. 1 and 2.

Sun discloses that the system 100 uses an individual's physical activity level to boost the accuracy of sensor data interpretation as well as to reduce energy consumption by turning the physiological sensor off or other restricting its functions under conditions (e.g., high levels of movement) when the collected data would not be accurate. APPLE-1031, [0034]. As another example, Zhao discloses a method of improving the quality of vital signs data including concurrently sensing data form a plurality of vital signs sensors over a period of time, determining a plurality of vital sign values; and fusing at least two vital sign values. APPLE-1032, Abstract. Fig. 8A of Zhao illustrates Zhao's device that contains an processor 840 that receives signals from accelerometer 885, a pulse oximetry sensor 880, and an ECG sensor 860. APPLE-1032, 19:54-22:3 and Fig. 8A. Zhao further discloses that the processor 840 includes a processor memory 841 to store instructions to control the sensors in the system to obtain the sensor data and process the information obtained. APPLE-1032, 20:60-67.Thus, a POSITA would have been motivated to modify Shmueli's device to include a motion sensor to detect activity level in order to improve accuracy of arrhythmia detection and would have had a reasonable expectation of success in doing so.

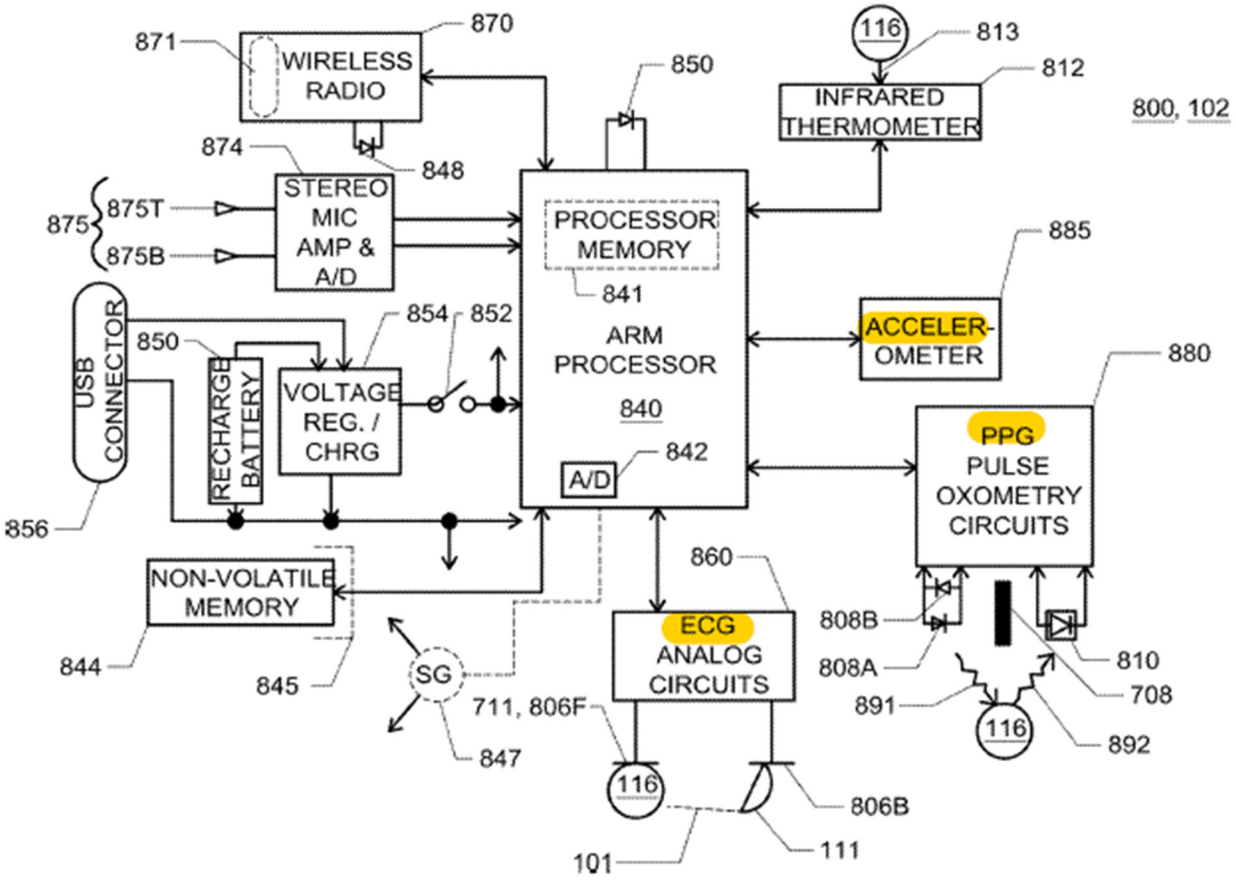


FIG. 8A

APPLE-1032, Fig. 8A (annotated)

This is expressly contemplated by Shmueli's explanation that "[i]t is expected that during the life of this patent many relevant methods and systems will be developed" and that its scope is intended to capture those developments. APPLE-1004, 15:3-5. Thus, a POSITA would have understood that incorporating Osorio's activity level monitoring techniques into Shmueli's heart monitoring device would have involved use of a known technique (e.g., monitoring activity level in detecting a pathological event) to known devices (e.g., monitoring devices

disclosed in Shmueli and Osorio), ready for improvement to yield predictable results.

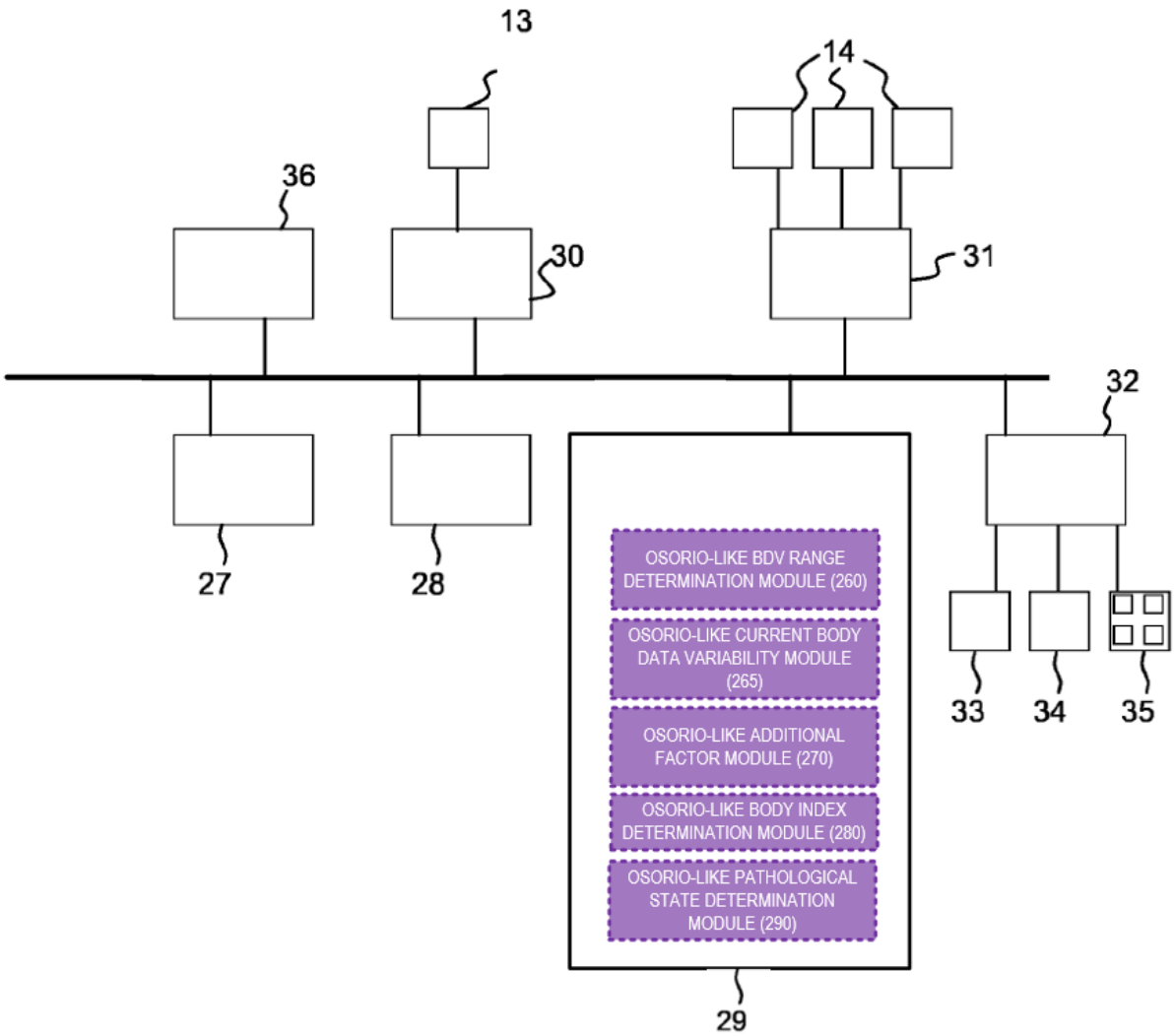
(b) *HRV Monitoring*

159. While incorporating Osorio's activity sensor and corresponding techniques for monitoring activity level, a POSITA would have found it natural to incorporate other aspects of Osorio's monitoring techniques for detecting a pathological condition (e.g., arrhythmia) based on HR and activity level. Examples of such aspects include deriving HRV from HR, and detecting a pathological state (e.g., arrhythmia) by comparing a current HRV to a non-pathological HRV range determined based on the activity level. APPLE-1005, [0003], Fig. 8. A POSITA also would have been motivated to incorporate Osorio's HRV analysis because it is less affected by noise. APPLE-1039, 52 ("This is a more robust method since the R-R time intervals are less affected by the noise.").

160. To implement this modification, a POSITA would have incorporated, into Shmueli's heart monitoring device, Osorio's software elements for processing data related to body indices and BDVs, including BDV determination module 260, BDV module 265, additional factor module 270, body index determination module 280, and pathological state determination module 290.

161. A POSITA would have found it obvious to implement this modification in several ways, consistent with the disclosures of both references.

For example, a POSITA would have found it obvious to configure processor 29 in Shmueli's heart monitoring device to execute operations related to BDV range monitoring, such as determining an HRV value from HR, comparing an HRV value with a non-pathological HRV range, and determining a pathological condition based on the comparison. *See* APPLE-1005, [0003], [0043], [0053], [0055], [0056], [0065], [0066], [0080], Figs. 1 and 8. A visual representation of this modification is shown in Shmueli's Figure 6 below (modification in purple):



Shmueli's Heart Monitoring Device (Modified Based on Osorio's HRV Monitoring)

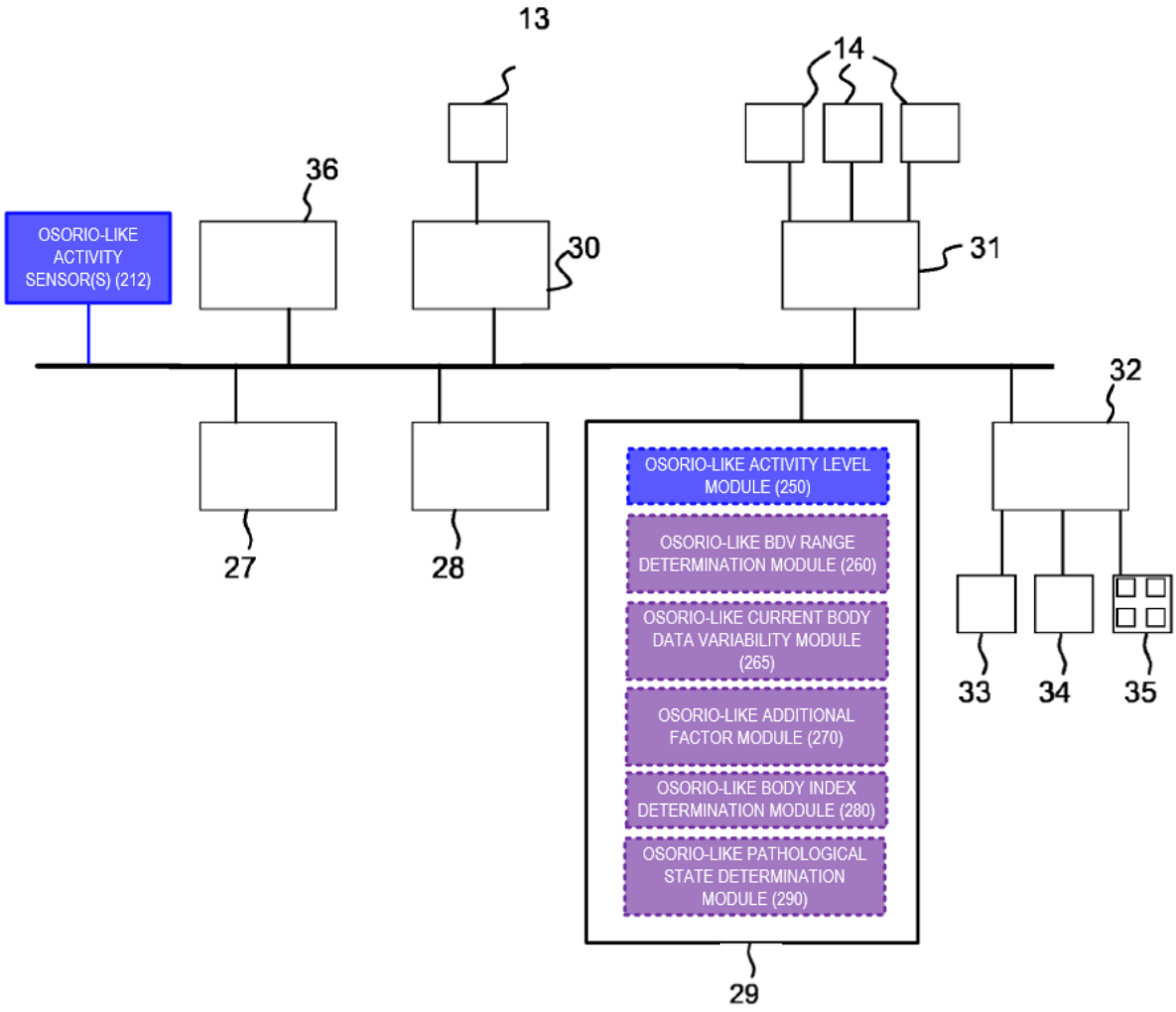
162. A POSITA would have been motivated to incorporate Osorio's software modules into Shmueli's heart monitoring device since doing so would have enabled use of HRV, which improves the pathological event detection capabilities compared to Shmueli's unmodified heart monitoring device. For example, although certain arrhythmias (e.g., tachycardia, bradycardia) are sufficiently detectable based on absolute heart rate values, detection of more frequently-occurring arrhythmias (e.g., atrial fibrillation) is improved when using HRV to prevent false detections. Thus, a POSITA would have understood that use of HRV by the Shmueli-Osorio device would have improved the detection of different types of arrhythmias.

163. A POSITA would have understood that the use of HRV analysis by the Shmueli-Osorio device would have been a simple application of a known technique to a known device to yield predictable results. Indeed, a POSITA would have found the use of HRV and a non-pathological HRV range as one of a finite number of identified, predictable solutions for detecting irregular heart conditions and would have had a reasonable expectation of success of implementing such detection in Shmueli, particularly in view of Osorio's disclosure of the same. For example, Asl-2008 describes two categories of arrhythmia detection techniques,

one based on the raw heart rate signal (e.g., ECG) and one based on HRV analysis. APPLE-1039, 52. A POSITA would have been motivated to choose HRV analysis because HRV extracted from R-R intervals of an ECG signal was known to be less affected by noise compared to processing morphological features of the ECG signal. *Id*. ("This is a more robust method since the R-R time intervals are less affected by the noise."). A POSITA also would have been motivated to employ Osorio's HRV analysis because, although certain types of arrhythmias (e.g., tachycardia or bradycardia) can be detected by absolute heart rate values, diagnosis of other types of arrhythmias (e.g., atrial fibrillation, the most common cardiac arrhythmia) uses HRV analysis.

164. Finally, a POSITA would have found it obvious that Osorio's technique of determining HRV from HR was conventional and it could have been applied to derive HRV from HR based on PPG data collected by Shmueli's oximetry sensor 13. APPLE-1005, [0042]. This is because (1) Shmueli teaches a software program that derives physiological parameters (pulse rate, pulse amplitude, pulse shape) from oximetry data (APPLE-1004, 12:14-22) and (2) Shmueli recognizes that "[d]eriving heart beat rate from oximetry, as well as other artifacts of the heart activity and blood flow, is also known in the art…" (*Id.*, 8:11-13). Indeed, a POSITA would have found it obvious that HRV is one example of the "artifacts of the heart activity and blood flow" addressed in Shmueli.

165. The figure below provides a visual depiction of the Shmueli-Osorio combination based on the modifications discussed above.



The Shmueli-Osorio Device

166. In the Shmueli-Osorio device, Shmueli would have been modified to incorporate Osorio's activity sensor and Osorio's monitoring technique to detect a pathological condition (e.g., arrhythmia) based on a user's HR, HRV, and activity level. Shmueli's oximetry sensor 13 would have determined HR information, and Osorio's activity sensor would have determined the user's activity level. The

combined device then would have determined a current HRV based on the HR information, determine the non-pathological HRV range based on the user's activity level, and compare the HRV to the non-pathological HRV range to detect an arrhythmia, as taught by Osorio. APPLE-1005, Fig. 8, [0077]-[0080]; APPLE-1010, [0042]-[0050]. Upon detection of arrhythmia based on HRV and activity level, the combined device would have notified the user to take an ECG measurement using Shmueli's ECG sensor. APPLE-1004, Fig. 7 and 12:6-30.

167. As discussed above, the Shmueli-Osorio device would have used Osorio's activity sensor to detect arrhythmia with increased accuracy by accounting for the user's activity level. APPLE-1005, [0029]. Moreover, using Shmueli's two-staged detection of irregular heart conditions using PPG data and ECG data, the Shmueli-Osorio device would have continuously monitored heart rhythm with an oximetry sensor and triggered an ECG measurement when an irregularity was detected. APPLE-1004, Abstract and Fig. 7. By accounting for activity level in determining when to notify the user to take an ECG, the Shmueli-Osorio device would have provided improved accuracy in determining when an ECG is needed, resulting in improved user satisfaction since the user would have been less bothered by false positives.

B. Claim 1

[1.0] A smart watch to detect the presence of an arrhythmia of a user, comprising:

168. To the extent the preamble is limiting, it is my opinion that the Shmueli-Osorio combination renders obvious element [1.0].

169. As discussed above in Section XI.A, Shmueli discloses a smart watch to detect the presence of an arrhythmia of a user.

170. In addition to Shmueli, Osorio also discloses using heart rate data to determine arrhythmia. APPLE-1005, [0046] and [0071]. For example, Osorio discloses "if the body signal is heart rate, then an instantaneous heart rate above the non-pathological heart rate range determined by the BDV range determination module 260 may indicate a tachycardia episode." APPLE-1005, [0046]. Osorio further discloses that "the severity may be measured by a magnitude and/or duration of a pathological state such as a seizure, a type of autonomic change associated with the pathological state (e.g., changes in heart rate, breathing rate, brain electrical activity, the emergence of one or more cardiac arrhythmias, etc.)." APPLE-1005, [0071].

171. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Thus, the Shmueli-Osorio combination renders obvious [1.0].

[1.1] a processing device

172. It is my opinion that the Shmueli-Osorio combination renders obvious element [1.1].

173. As discussed above in Section XI.A, Shmueli discloses a smart watch containing a processing device that controls the operations of Shmueli's PPG sensor and ECG sensor.

174. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Thus, the Shmueli-Osorio combination renders obvious [1.1].

[1.2] a photoplethysmography ("PPG") sensor operatively coupled to the processing device;

175. It is my opinion that the Shmueli-Osorio combination renders obvious element [1.2].

176. As discussed above in Section XI.A, Shmueli discloses a PPG sensor operatively coupled to the processing device.

177. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. Thus, the Shmueli-Osorio combination renders obvious [1.2].

[1.3] an ECG sensor, comprising two or more ECG electrodes, the ECG sensor operatively coupled to the processing device;

178. It is my opinion that the Shmueli-Osorio combination renders obvious element [1.3].

179. As discussed above in Section XI.A, Shmueli discloses an ECG sensor, comprising three ECG electrodes and operatively coupled to the processing device.

180. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. Thus, the Shmueli-Osorio combination renders obvious [1.3].

[1.4] a display operatively coupled to the processing device; and

181. It is my opinion that the Shmueli-Osorio combination renders obvious element [1.4].

182. As discussed above in Section XI.A, Shmueli discloses a display operatively coupled to the processing device.

183. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Thus, the Shmueli-Osorio combination renders obvious [1.4].

[1.5] a memory, operatively coupled to the processing device, the memory having instructions stored thereon that, when executed by the processing device, cause the processing device to:

184. It is my opinion that the Shmueli-Osorio combination renders obvious element [1.5].

185. As discussed above in Section XI.A, Shmueli discloses a memory operatively coupled to the processing device and having instructions to be executed by the processing device.

186. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Thus, the Shmueli-Osorio combination renders obvious [1.5].

[1.6] receive PPG data from the PPG sensor;

187. It is my opinion that the Shmueli-Osorio combination renders obvious element [1.6].

188. As discussed above in Section XI.A, Shmueli discloses a memory with instructions that cause the processing device to receive PPG data from the PPG sensor.

189. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Shmueli's PPG sensor is used to determine heart rate

information, and Osorio's motion sensor is used to determine the user's activity level. Thus, the Shmueli-Osorio combination renders obvious [1.6].

[1.7] detect, based on the PPG data, the presence of an arrhythmia;

190. It is my opinion that the Shmueli-Osorio combination renders obvious element [1.7].

191. As discussed above in Section XI.A, Shmueli discloses a memory with instructions that cause the processing device to detect, based on the PPG data, the presence of arrhythmia.

192. In addition to Shmueli, Osorio also discloses using heart rate data to determine arrhythmia. APPLE-1005, [0046] and [0071]. For example, Osorio discloses "if the body signal is heart rate, then an instantaneous heart rate above the non-pathological heart rate range determined by the BDV range determination module 260 may indicate a tachycardia episode." APPLE-1005, [0046]. Osorio further discloses that "the severity may be measured by a magnitude and/or duration of a pathological state such as a seizure, a type of autonomic change associated with the pathological state (e.g., changes in heart rate, breathing rate, brain electrical activity, the emergence of one or more cardiac arrhythmias, etc.)." APPLE-1005, [0071].

193. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and

activity level analysis. Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. Then the combined device determines current HRV based on the heart rate information (from the PPG sensor), determines the non-pathological HRV range based on the user's activity level and compares the HRV to the non-pathological HRV range to determine an arrhythmia, as taught by Osorio. APPLE-1005, Fig. 8 and [0077]-[0080]; APPLE-1010, [0042]-[0050]. Thus, the Shmueli-Osorio combination renders obvious [1.7].

[1.8] receive ECG data from the ECG sensor; and

194. It is my opinion that the Shmueli-Osorio combination renders obvious element [1.8].

195. As discussed above in Section XI.A, Shmueli discloses a memory with instructions that cause the processing device to receive ECG data from the ECG sensor.

196. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Upon detection of an arrhythmia, the combined device notifies the user to take an ECG measurement using Shmueli's ECG sensor. APPLE-1004, Fig. 7 and 12:6-30. Then the combined device confirms the detection of the arrhythmia using the ECG data. APPLE-1004, Fig. 7 and 13:16-19

("Optionally but preferably the software program proceeds to element 50 to search for correlations between the SpO2 signal and the ECG signal to produce new detection parameters, or modify existing detection parameters, so as to enhance the detection algorithms of the irregular heart conditions."). Thus, the Shmueli-Osorio combination renders obvious [1.8].

[1.9] confirm the presence of the arrhythmia based on the ECG data.

197. It is my opinion that the Shmueli-Osorio combination renders obvious element [1.9].

198. As discussed above in Section XI.A, Shmueli discloses a memory with instructions that cause the processing device to confirm the presence of the arrhythmia based on the ECG data.

199. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Upon detection of the arrhythmia, the combined device notifies the user to take an ECG measurement using Shmueli's ECG sensor. APPLE-1004, Fig. 7 and 12:6-30. Then, the combined device confirms the detection of the arrhythmia using the ECG data. APPLE-1004, Fig. 7 and 13:16-19 ("Optionally but preferably the software program proceeds to element 50 to search for correlations between the SpO2 signal and the ECG signal to produce new detection parameters, or modify existing detection parameters, so as to enhance the

detection algorithms of the irregular heart conditions."). Thus, the Shmueli-Osorio combination renders obvious [1.9].

C. Claim 2

[2.0] The smart watch of claim 1, further comprising a motion sensor operatively coupled to the processing device, wherein to detect the presence of the arrhythmia, the processing device is configured to:

200. It is my opinion that the Shmueli-Osorio combination renders obvious element [2.0].

201. As discussed above in Section XII.A, a POSITA would have been motivated to add Osorio's motion sensor and activity level analysis to Shmueli's device because Osorio teaches that considering activity level improves detection of a pathological condition (e.g., arrhythmia) based on heart rate. APPLE-1005, [0029].

202. Osorio discloses monitoring the user's activity level using a kinetic sensor. APPLE-1005, Abstract, [0003]-[0006] and [0028] ("a medical device capable of monitoring an **activity type and/or level** of a patient and dynamically determining a non-pathological BDV range based upon an activity type and/or level of the patient. … **An activity level or state (e.g., awake or asleep)** of the patient may in some embodiments be determined from a **kinetic sensor such as an accelerometer**."), [0033] (discussing an activity sensor 212), [0057], [0061] and Fig. 1. *See also* APPLE-1010, [0025]-[0026] and [0045]-[0050].

203. A POSITA would have understood that Osorio's "kinetic sensor" (e.g., accelerometer) is a motion sensor within the meaning of the '731 patent. For example, the '731 patent discloses "[a]n advisory condition for recording an ECG can also occur when a measured heart rate increases rapidly without a corresponding increase in activity monitored by, for example, an **accelerometer**." APPLE-1001, 25:13-15. Thus, as shown in Fig. 1 below, Osorio discloses a motion sensor. *See* APPLE-1005, Fig. 1; APPLE-1010, Fig. 1.

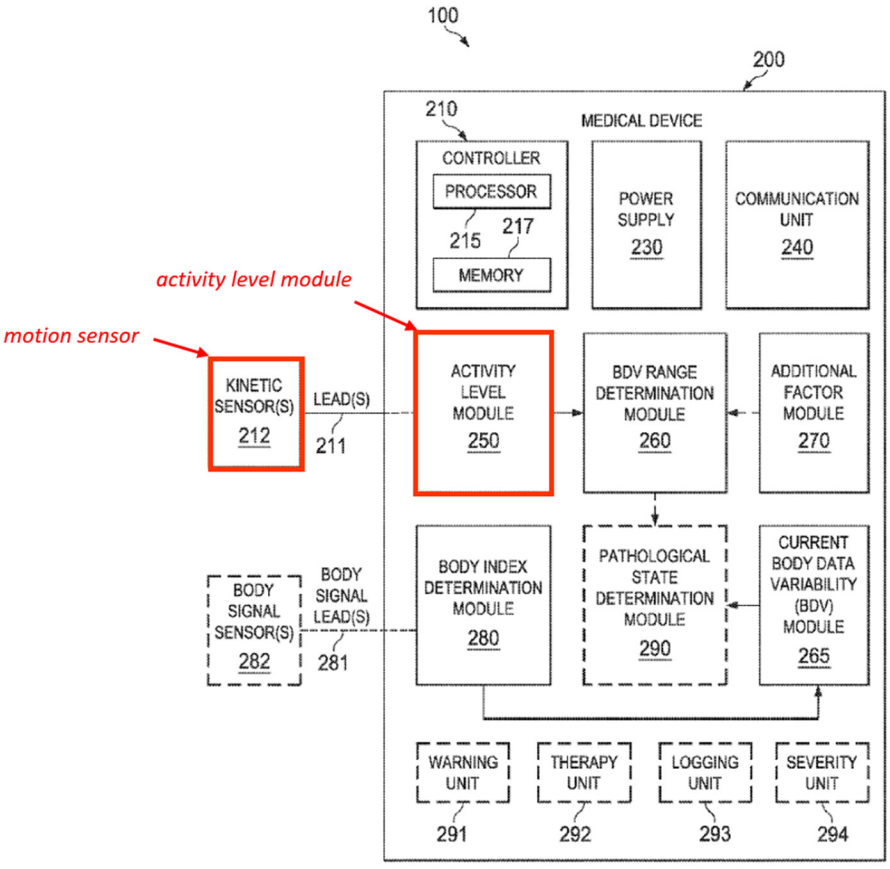


FIG. 1

APPLE-1005, Fig. 1 (annotated).

204. Osorio also discloses sensing an activity level using the activity level module 250. APPLE-1005, [0035]-[0036] (discussing an "activity level module 250, configured to determine an activity type and/or level of the patient, based on at least in part on body signal data collected by activity sensor(s) 212."). Osorio "recognizes that to determine (using body systems and their features) whether a body system is functioning pathologically or non-pathologically with a ***clinically worthwhile degree of accuracy and reliability***, one must take into account ***the type and/or level of activity being performed by a subject*** at the time the pathological/non-pathological determination is made." APPLE-1005, [0029]. As Osorio explains, "it is imperative to know whether or not ***a given increase in heart rate is associated with a change in activity*** (e.g., physical or emotional) and if such a change in activity is occurring, to determine ***if the heart rate increase is commensurate with said activity type and level***." *Id.* Thus, Osorio discloses sensing an activity level of said first user with a motion sensor. *See also*, APPLE-1010, [0025]-[0026] and [0045]-[0050].

205. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Shmueli's PPG sensor is used to determine heart rate information, and ***Osorio's motion sensor is used to determine the user's activity level***. Thus, the Shmueli-Osorio combination renders obvious [2.0].

[2.1] receive motion sensor data from the motion sensor; and

206. See element [2.0]. As discussed above, in the Shmueli-Osorio combination, Shmueli's PPG sensor is used to determine heart rate information, and ***Osorio's motion sensor is used to determine the user's activity level***. A POSITA would have understood that Shmueli's processing device is configured to receive motion sensor data from Osorio's motion sensor.

[2.2] determine, from motion sensor data, that the user is at rest.

207. Osorio discloses determining from the motion sensor data that the user is at rest. EX1005, [0028] ("**An activity level or state (e.g., awake or asleep)** of the patient may in some embodiments be determined from a kinetic sensor such as an accelerometer."). A POSTIA would have understood that the user is at rest when her activity level is low or when the user is asleep. As shown below in Fig. 4A, Osorio discloses "[b]oth the upper and lower bounds of the non-ictal [sic] HR region increase as activity level increases (e.g., from a sleep state to a **resting**, awake state) and reach their highest values for strenuous exertion… Another non-pathological HRV range R2 may be established by upper and lower boundaries 410 and 420 for **resting awake activity level A2**." APPLE-1005, [0058].

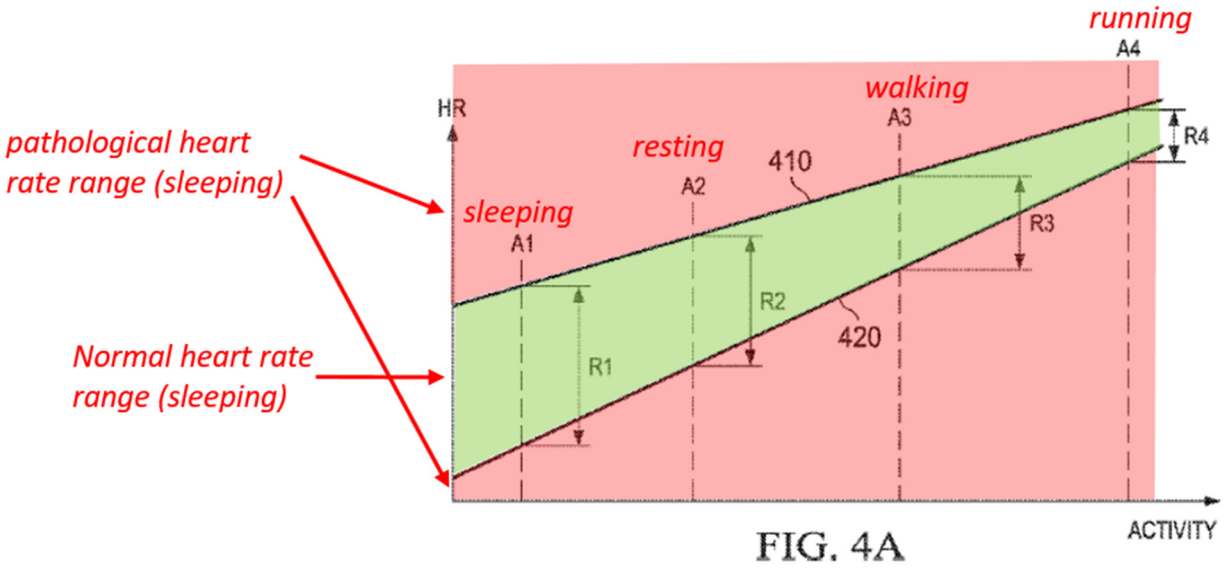


FIG. 4A

APPLE-1005, Fig. 4A (annotated).

208. Thus, Osorio discloses determining, from the motion sensor data, that the user is at rest (e.g., when the activity level is at A2).

209. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Shmueli's PPG sensor is used to determine heart rate information, and ***Osorio's motion sensor is used to determine the user's activity level*** including whether the user is at rest. Thus, the Shmueli-Osorio combination renders obvious [2.0].

D. Claim 4

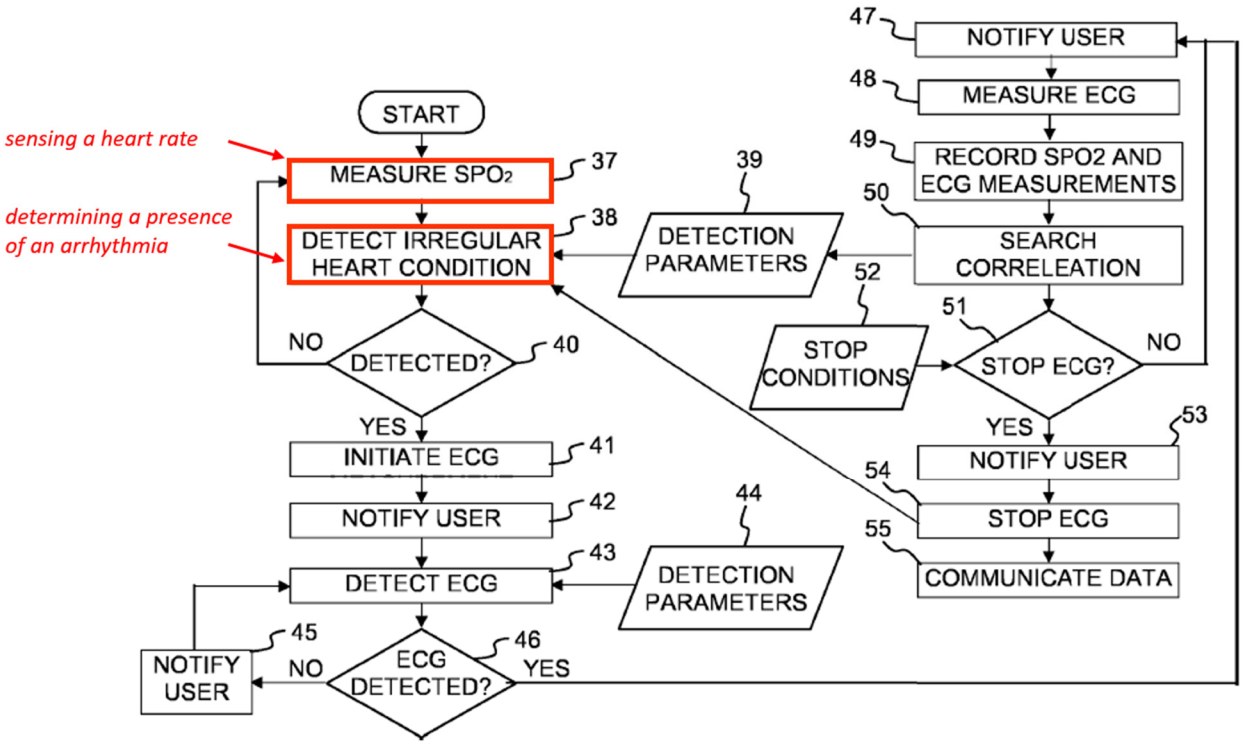
[4.0] The smart watch of claim 2, wherein to detect the presence of the arrhythmia, the processing device is configured to: determine heartrate

variability ("HRV") data from the PPG data; and detect, based on the HRV data, the presence of the arrhythmia.

210. It is my opinion that the Shmueli-Osorio combination renders obvious element [4.0].

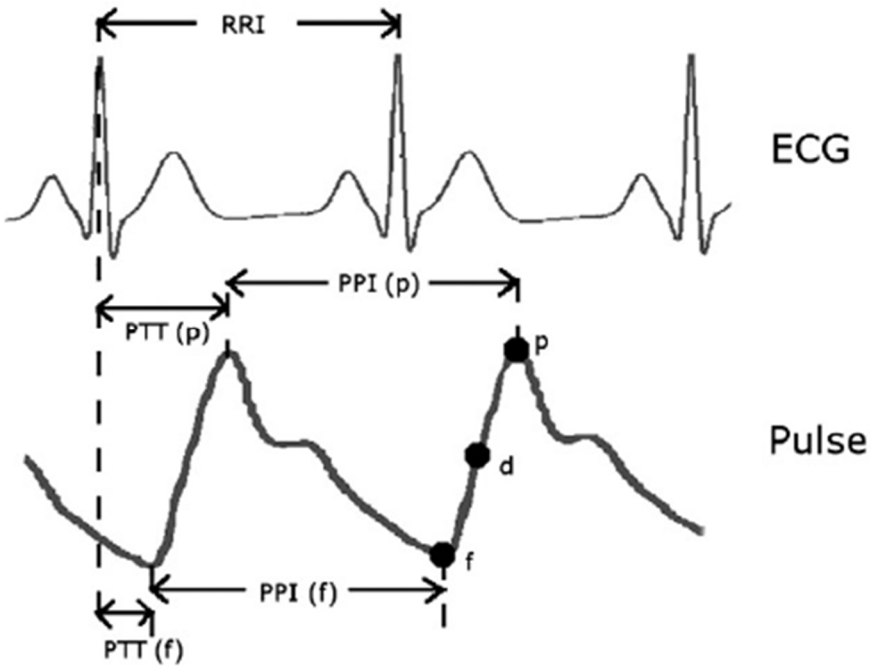
211. As discussed above in Section XII.A, in the Shmueli-Osorio combination, the combined device includes a mobile computing device that executes the software program in Fig. 7 to detect arrhythmia. As shown in Fig. 7 below, the software program "starts in element 37 by measuring SpO2" and then "proceeds to element 38 to derive from the SpO2 measurement **physiological parameters such as pulse rate**, pulse amplitude, pulse shape, rate of blood flow, etc." and "to detect various irregularities of the heart condition." APPLE-1004, 12:9-17. In element 38, Shmueli's method derives the user's pulse rate from the SpO2 measurement in element 37. *Id*.

Fig. 7



APPLE-1004, Fig. 7 (annotated).

212. As the pulse period derived from PPG data is directly related to the cardiac activity, the physiological information derived from RR intervals of ECG can also be derived from the pulse period of PPG. APPLE-1014, p. 480. This is because electrical activity of the heart (ECG) is followed by the contraction of the heart and a spread of the pulsatile wave of blood to the periphery (PPG). APPLE-1014, p. 480. Thus, a PPG signal includes information about both heart rate and heart rate variability. APPLE-1025, p. 16. Many studies verify the high correlation between RR intervals (RRI) obtained from ECG and PP intervals (PPI) obtained from PPG. APPLE-1025, p. 16; APPLE-1018, Fig. 1.



APPLE-1018, Fig. 1.

213. Indeed, the ’731 patent also discloses detecting heart rate using the PPG sensor. APPLE-1001, 8:41-45. During prosecution, Applicant distinguished prior art by arguing that the claimed “heart rate sensor” is different from the ECG sensor in the prior art. APPLE-1002, 342-347. Similar to the ’731 patent, Shmueli discloses measuring heart rate with a PPG sensor. APPLE-1004, 9:8-10 (disclosing “an oximetry sensor”); 7:25-27 (explaining that the terms oximetry and photoplethysmography have the same meaning). In addition, Shmueli explains that “[d]eriving heart beat rate from oximetry” was known in the art. APPLE-1004, 8:11-13. Thus, Shmueli discloses detecting heart rate using a heart rate sensor in the form of a PPG sensor.

214. A POSITA would have found it obvious that Shmueli’s method

derives HRV based on the heart rate data because HRV is a common physiological parameter derived from heart rate data to detect irregular heart conditions. APPLE-1012, p. 96 ("HRV analysis became a critical tool in cardiology for the diagnosis of heart diseases."); APPLE-1039, p. 52 ("This is a more robust method since the R-R time intervals are less affected by the noise."). In addition, a POSITA would have been motivated to determine HRV based on the heart rate data because, although certain types of arrhythmias (e.g., tachycardia or bradycardia) can be detected by absolute heart rate values, diagnosis of other types of arrhythmias (e.g., atrial fibrillation, one of the most common cardiac arrhythmia) requires HRV analysis. By the Critical Date, it was well-known that HRV can be accurately derived from heart rate sensed using either PPG or ECG data. APPLE-1013, Abstract ("Our results demonstrate that the parameters of PPGV are highly correlated with the parameters of HRV."); APPLE-1014, Abstract ("HRV can also be reliably estimated from the PPG based PP interval method."); APPLE-1015, Abstract ("Our results confirm that PPG provides accurate interpulse intervals from which HRV measures can be accurately derived in healthy subjects under ideal conditions, suggesting this technique may prove a practical alternative to ECG for HRV analysis."). Thus, while Shmueli does not provide a detailed disclosure of how to detect arrhythmia based on heart rate sensed using the PPG sensor, a POSITA would have known how and found it obvious to use Shmueli's

wrist-worn device to determine HRV from the sensed heart rate in order to detect the arrhythmia based on their knowledge, training, and experience in the field as of the Critical Date.

215. In addition, Osorio discloses detecting arrhythmia by determining HRV from the sensed heart rate from the heart rate sensor. APPLE-1005, Fig. 1, [0033], [0042], [0043], [0053] and [0080] ("***the body index value may be heart rate and the BDV may be HRV***."). *See also*, APPLE-1010, [0035] ("For example, the body data variability module 165 may comprise an HRV module 310 configured ***to determine HRV from heart rate data***."). As shown below in Fig. 1, Osorio discloses determining a body index at a body index determination module 280 based on a body signal from a body signal sensor 282, and then determining a current BDV at a current BDV module 265 based on the body index. APPLE-1005, Fig. 1, [0033], [0042] and [0043]. Osorio discloses that the body index value may be heart rate and the BDV value may be HRV. APPLE-1005, [0080] ("***the body index value may be heart rate and the BDV may be HRV***."). Osorio also discloses "the current BDV module 265 may comprise a **HRV module 310 configured to determine HRV from heart rate data**." APPLE-1005, [0053]. Thus, Osorio discloses determining HRV from the sensed heart rate from the heart rate monitor. *See* APPLE-1005, Fig. 1; APPLE-1010, [0035] ("For example, the body data variability module 165 may comprise an HRV module 310 configured ***to***

determine HRV from heart rate data.").

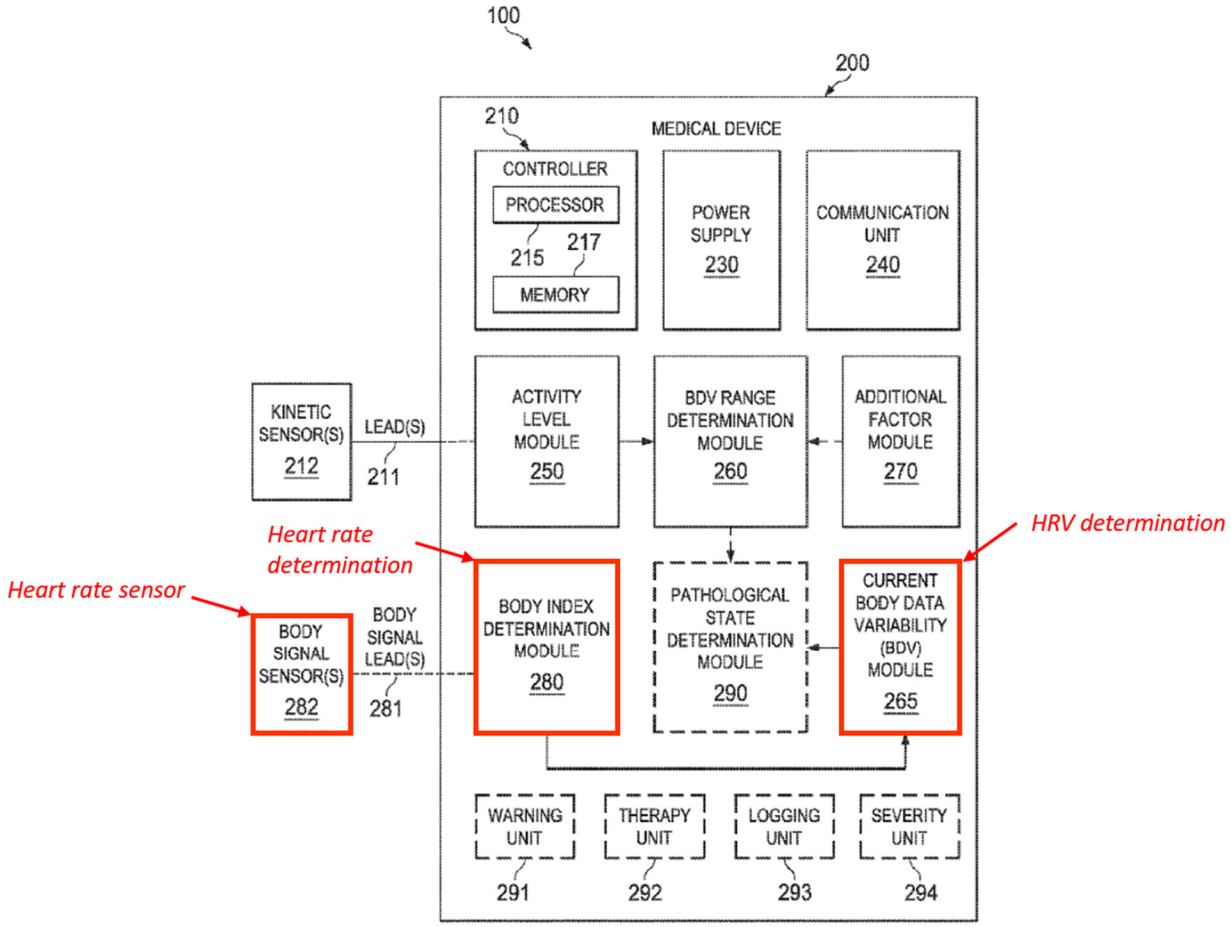


FIG. 1

APPLE-1005, Fig. 1 (annotated).

216. As discussed above in Section XII.A, a POSITA would have been motivated to combine Shmueli with Osorio because Shmueli does not disclose specifically how to detect an irregular heart condition (e.g., arrhythmia) based on heart rate data from the SpO2 measurement. Given the lack of details in Shmueli, a POSITA would have had reason to turn to other references, such as Osorio, that

disclose how to detect irregular heart conditions (e.g., arrhythmia) based on heart rate data. Specifically, Fig. 8 of Osorio discloses how to detect arrhythmia based on heart rate data:

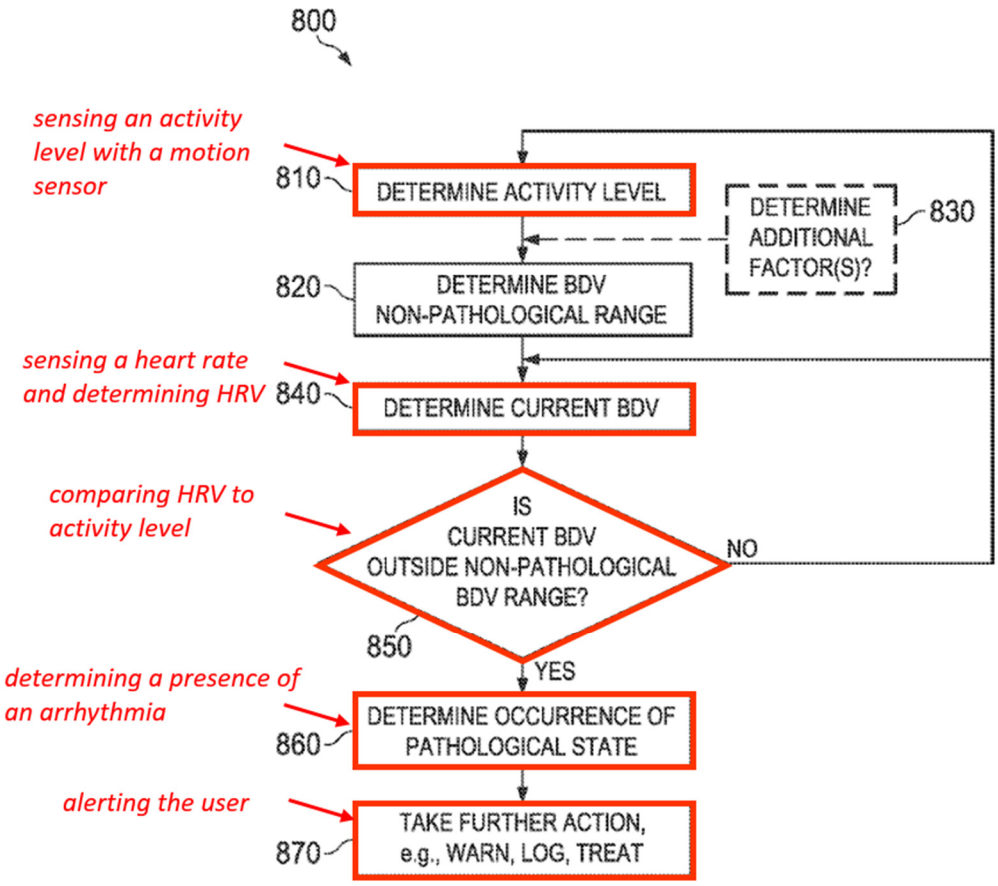


FIG. 8

APPLE-1005, Fig. 8 (annotated).

217. As shown in Fig. 8, an activity level is determined at 810, and a non-pathological BDV range (e.g., HRV range) is determined at 820, based on the activity level. APPLE-1005, [0077]. A current BDV (e.g., HRV) is determined at 840 and compared to the non-pathological BDV range. APPLE-1005, [0078]. If the current BDV is outside the non-pathological range, then a pathological state is

determined at 860. APPLE-1005, [0078]. Thereafter, a further action, such as **warning**, treating, or logging the occurrence and/or severity of the pathological state is taken at 870. APPLE-1005, [0078]. Osorio further discloses "the body index value may be heart rate and the BDV value may be HRV." APPLE-1005, [0080]. Osorio also discloses: "By monitoring the patient's activity level, HR, and HRV, it is possible to determine when the patient's HRV falls outside the non-pathological ranges as the patient's activity levels change over time." APPLE-1005, [0066]. Accordingly, as an additional reason to combine Shmueli and Osorio, a POSITA would have found it obvious to employ, in Shmueli's detection of an irregular heart condition, Osorio's process of comparing HRV to a non-pathological HRV range (dynamically selected based on activity level) to identify irregular heart conditions (e.g., arrhythmia). HRV is a well-known parameter used to detect heart irregularities and a POSITA would have readily appreciated the benefits of using HRV and a non-pathological HRV range to perform the detection of an irregular heart condition in Shmueli, particularly given the lack of details offered in Shmueli's disclosure. ; APPLE-1012, p. 96 ("HRV analysis became a critical tool in cardiology for the diagnosis of heart diseases."); APPLE-1039, p. 52 ("This is a more robust method since the R-R time intervals are less affected by the noise."). With Shmueli's lack of details, use of Osorio's HRV analysis in Shmueli would have been seen as a simple application of a known technique to a known

device to yield predictable results. Indeed, a POSITA would have found use of HRV and a non-pathological HRV range as one of a finite number of identified, predictable solutions for detecting irregular heart conditions and would have had a reasonable expectation of success of implementing such detection in Shmueli, particularly in view of Osorio's disclosure of the same. For example, Asl 2008 describes two categories of arrhythmia detection techniques, one based on the raw heart rate signal (e.g., ECG) and one based on HRV analysis. APPLE-1039, p. 52. A POSITA would have been motivated to choose HRV analysis because it is less affected by noise. APPLE-1039, p. 52 ("This is a more robust method since the R-R time intervals are less affected by the noise."). In addition, a POSITA would have been motivated to employ Osorio's HRV analysis because, although certain types of arrhythmias (e.g., tachycardia or bradycardia) can be detected by absolute heart rate values, diagnosis of other types of arrhythmias (e.g., atrial fibrillation, one of the most common cardiac arrhythmia) requires HRV analysis.

218. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. The combined device (e.g., Shmueli's wrist-worn device modified to perform Osorio's activity level and HRV analysis) then ***determines current HRV based on the heart rate information***, determines the non-pathological HRV range based on the user's

activity level, and ***compares the HRV to the non-pathological HRV range to determine an arrhythmi***a, as taught by Osorio. APPLE-1005, Fig. 8 and [0077]-[0080]; APPLE-1010, [0042]-[0050]. Thus, the Shmueli-Osorio combination renders obvious [4.0].

E. Claim 7

[7.0] The smart watch of claim 1, wherein the processing device is further configured to: extract one or more features from the PPG data; and detect, based on the one or more features, the presence of the arrhythmia.

219. It is my opinion that the Shmueli-Osorio combination renders obvious element [7.0].

220. As discussed above in Section XI.B, although Shmueli does not specifically disclose how to detect arrhythmia based on PPG data, a POSITA would have found it obvious to extract certain features (e.g., RR intervals and HRV) from the PPG data and to determine arrhythmia based on these features.

221. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Shmueli's PPG sensor is used to determine heart rate information (a feature extracted from the PPG data), and Osorio's motion sensor is used to determine the user's activity level. The combined device then determines current HRV (a feature extracted from the PPG data) based on the heart rate information, determines the non-pathological HRV range based on the user's

activity level, and compares the HRV to the non-pathological HRV range to determine an arrhythmia, as taught by Osorio. APPLE-1005, Fig. 8 and [0077]-[0080]; APPLE-1010, [0042]-[0050]. In other words, the combined device extracts ***features including the heart rate and the HRV*** from the PPG data and detects arrhythmia based on these extracted features. Thus, the Shmueli-Osorio combination renders obvious [7.0].

F. Claim 12

[12.0] The smart watch of claim 1, wherein the processing device is further configured to generate a notification of the detected arrhythmia.

222. It is my opinion that the Shmueli-Osorio combination renders obvious element [12.0].

223. As discussed above in Section XI.C, Shmueli's processing device is configured to generate a notification of the detected arrhythmia. Shmueli renders obvious generating both a notification of the initially detected arrhythmia based on PPG data and a second notification of the confirmed arrhythmia based on the PPG and ECG data.

224. In addition, Osorio also discloses generating a notification of the detected arrhythmia. APPLE-1005, [0071] (discussing "declaring a pathological state" and "issuing a warning to the patient or a caregiver regarding the pathological state … the emergence of one or more cardiac arrhythmias"). Fig. 1 of Osorio also shows a "warning unit 291" that is used to issue such notifications:

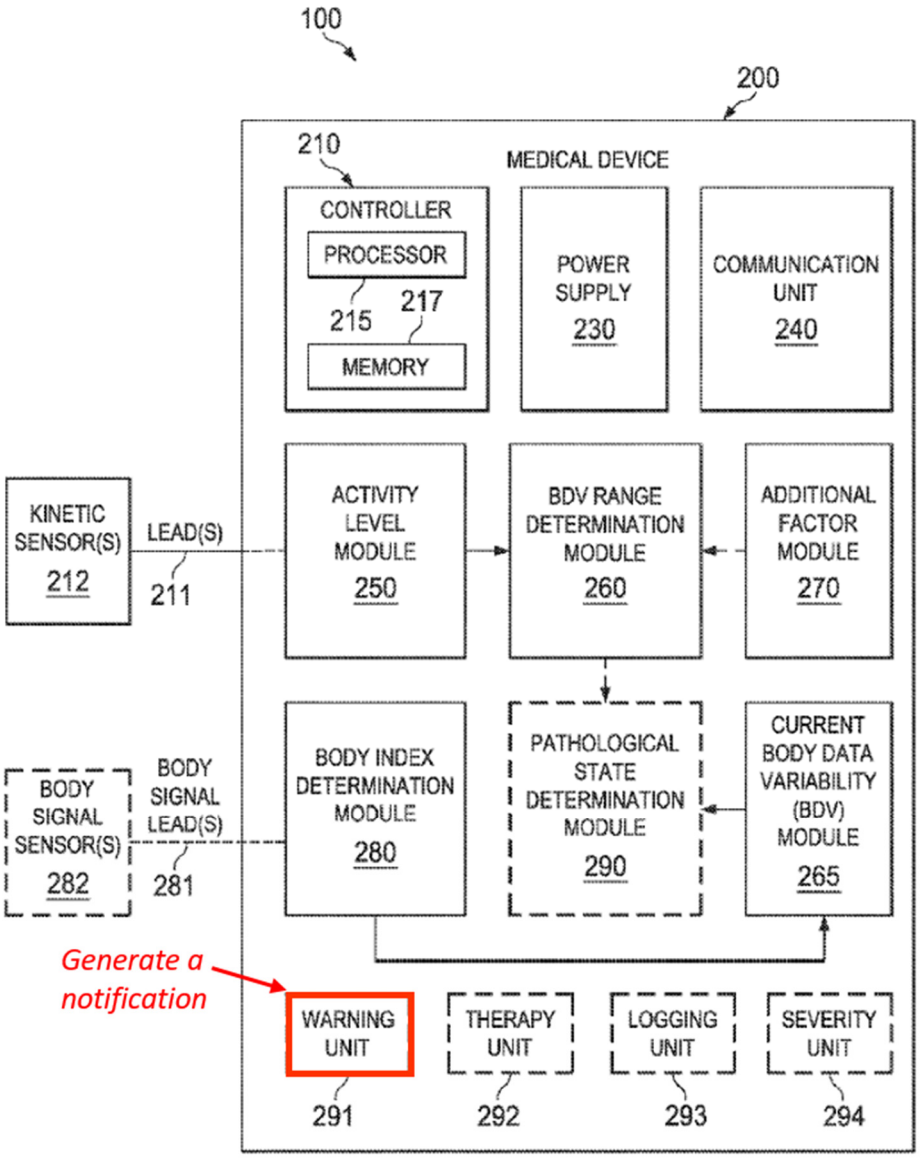


FIG. 1

APPLE-1005, Fig. 1 (annotated).

225. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Upon detection of an arrhythmia, ***the combined device notifies the user of the detected arrhythmia*** to prompt the user to take an ECG

measurement using Shmueli's ECG sensor. APPLE-1004, Fig. 7 and 12:6-30. After the ECG is measured, the combined device confirms the presence of arrhythmia based on the ECG and PPG data and notifies the user of the confirmed arrhythmia. APPLE-1004, 13:16-19 ("Optionally but preferably the software program proceeds to element 50 to search for correlations between the SpO2 signal and the ECG signal to produce new detection parameters, or modify existing detection parameters, so as to enhance the detection algorithms of the irregular heart conditions."). Thus, the Shmueli-Osorio combination renders obvious [12.0].

G. Claim 13

[13.0] The smart watch of claim 1, further comprising a biometric data sensor, wherein the processing device is further configured to: receive biometric data of the user from the biometric data sensor; and detect, based on the biometric data, the presence of the arrhythmia.

226. It is my opinion that the Shmueli-Osorio combination renders obvious element [13.0].

227. As discussed above in Section XI.D, Shmueli's smart watch comprises a biometric data sensor (PPG sensor or ECG sensor), wherein the processing device is configured to receive biometric data (PPG data or ECG data) from the biometric sensor and detect the presence of arrhythmia based on the biometric data.

228. In addition, the '731 patent describes its biometric data sensor as including "a hand-held electrocardiogram (ECG) sensor, **a wrist-worn activity**

sensor, a blood pressure monitor, a personal weighing scale, a body fat percentage sensor, a personal thermometer, a pulse oximeter sensor, or any mobile health monitor or sensor." APPLE-1001, 4:57-61. Thus, a POSITA would have understood that Osorio's motion sensor also is a biometric data sensor and that the motion sensor data is biometric data within the meaning of the '731 patent.

229. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. The combined device then determines current HRV based on the heart rate information, determines the non-pathological HRV range based on the user's ***activity level (as determined based on the motion sensor data)***, and compares the HRV to the non-pathological HRV range to determine an arrhythmia, as taught by Osorio. APPLE-1005, Fig. 8 and [0077]-[0080]; APPLE-1010, [0042]-[0050]. Thus, the Shmueli-Osorio combination renders obvious [13.0].

H. Claim 14

[14.0] The smart watch of claim 13, wherein the biometric data comprises at least one of: a temperature, a blood pressure, or an inertial data of the user.

230. It is my opinion that the Shmueli-Osorio combination renders obvious element [14.0].

231. The '731 patent generally describes the biometric data sensor as

including "a hand-held electrocardiogram (ECG) sensor, **a wrist-worn activity sensor**, a blood pressure monitor, a personal weighing scale, a body fat percentage sensor, a personal thermometer, a pulse oximeter sensor, or any mobile health monitor or sensor." APPLE-1001, 4:57-61. Thus, a POSITA would have understood that Osorio's motion sensor also is a biometric data sensor and that the motion sensor data is biometric data within the meaning of the '731 patent.

232. As discussed above in Section XII.A, a POSITA would have been motivated to add Osorio's motion sensor and activity level analysis to Shmueli's device because Osorio teaches that considering activity level improves detection of arrhythmia based on heart rate. APPLE-1005, [0029]. Osorio discloses monitoring the user's activity level using a kinetic sensor, such as an accelerometer. APPLE-1005, Abstract, [0003]-[0006], [0028], [0033], [0057], [0061] and Fig. 1. *See also* APPLE-1010, [0025]-[0026] and [0045]-[0050]. The '731 patent also discloses a motion sensor in the form of an accelerometer. APPLE-1001, 25:5-9. It was well-know that the accelerometer is an inertial sensor and measures motion based on inertial data. APPLE-1045, 1163. Thus, a POSITA would have understood that Osorio's "kinetic sensor" (e.g., accelerometer) measures "inertial data" within the meaning of the '731 patent.

233. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli's PPG sensor is used to determine heart rate information,

and ***Osorio's motion sensor (e.g., accelerometer) is used to determine the user's activity level (based on an inertial data from the motion sensor)***. A POSITA would have understood that Osorio's motion sensor is a biometric data sensor within the meaning of the '731 patent, and that the combined device receives biometric data in the form of inertial data from Osorio's motion sensor. Thus, the Shmueli-Osorio combination renders obvious [14.0].

I. Claim 16

[16.0] The smart watch of claim 1, the processing device further to receive the ECG data from the ECG sensor in response to receiving an indication of a user action.

234. It is my opinion that the Shmueli-Osorio combination renders obvious element [16.0].

235. As discussed above in Section XI.E, Shmueli's processing device is configured to receive ECG data from the ECG sensor in response to receiving an indication of a user action.

236. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Upon detection of an arrhythmia, ***the combined device notifies the user to take an ECG and detects an ECG in response to a user action.*** APPLE-1004, 3:14-19, Figs. 4 and 7. Thus, the Shmueli-Osorio combination renders obvious [16.0].

J. Claim 17

[17.0]. A method to detect the presence of an arrhythmia of a user on a smart watch, comprising:

237. To the extent the preamble is limiting, it is my opinion that the Shmueli-Osorio combination renders obvious element [17.0]. See element [1.0].

[17.1] receiving PPG data from a PPG sensor of the smartwatch;

238. It is my opinion that the Shmueli-Osorio combination renders obvious element [17.1]. See element [1.6].

[17.2] detecting by a processing device, based on the PPG data, the presence of an arrhythmia;

239. It is my opinion that the Shmueli-Osorio combination renders obvious element [17.2]. See element [1.7].

[17.3] receiving ECG data from an ECG sensor of the smartwatch; and

240. It is my opinion that the Shmueli-Osorio combination renders obvious element [17.3]. See element [1.8].

[17.4] confirming the presence of the arrhythmia based on the ECG data.

241. It is my opinion that the Shmueli-Osorio combination renders obvious element [17.4]. See element [1.9].

K. Claim 18

[18.0] The method of claim 17, wherein detecting the presence of the arrhythmia comprises:

242. It is my opinion that the Shmueli-Osorio combination renders obvious element [18.0]. See element [2.0].

[18.1] receiving motion sensor data from a motion sensor of the smartwatch; and

243. It is my opinion that the Shmueli-Osorio combination renders obvious element [18.1]. See element [2.1].

[18.2] determine, from motion sensor data, that the user is at rest.

244. It is my opinion that the Shmueli-Osorio combination renders obvious element [18.2]. See element [2.2].

L. Claim 20

[20.0] The method of claim 18, wherein detecting the presence of the arrhythmia comprises: determining heartrate variability ("HRV") data from the PPG data; and detecting, based on the HRV data, the presence of the arrhythmia.

245. It is my opinion that the Shmueli-Osorio combination renders obvious element [20.0]. See element [4.0].

M. Claim 23

[23.0] The method of claim 17, further comprising generating a notification of the detected arrhythmia.

246. It is my opinion that the Shmueli-Osorio combination renders obvious element [23.0]. See element [12.0].

N. Claim 24

[24.0] The method of claim 17, further comprising receiving the ECG data from the ECG sensor in response to receiving an indication of a user action.

247. It is my opinion that the Shmueli-Osorio combination renders obvious element [24.0]. See element [16.0].

O. Claim 25

[25.0] A non-transitory computer-readable storage medium including instructions that, when executed by a processing device, cause the processing device to:

248. It is my opinion that the Shmueli-Osorio combination renders obvious element [25.0].

249. As discussed above in Section XI.I, Shmueli's device includes a non-stationary computer-readable storage medium including instructions to be executed by Shmueli's processing device.

250. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli is modified by incorporating Osorio's motion sensor and activity level analysis. Thus, the Shmueli-Osorio combination renders obvious [16.0].

[25.1] receive PPG data from a PPG sensor of the smartwatch;

251. It is my opinion that the Shmueli-Osorio combination renders obvious element [25.1]. See element [1.6].

[25.2] detect by the processing device, based on the PPG data, the presence of an arrhythmia;

252. It is my opinion that the Shmueli-Osorio combination renders obvious element [25.2]. See element [1.7].

[25.3] receive ECG data from an ECG sensor of the smartwatch; and

253. It is my opinion that the Shmueli-Osorio combination renders obvious element [25.3]. See element [1.8].

[25.4] confirm the presence of the arrhythmia based on the ECG data.

254. It is my opinion that the Shmueli-Osorio combination renders obvious element [25.4]. See element [1.9].

P. Claim 26

[26.0] The non-transitory computer-readable storage medium of claim 25, wherein the processing device is further configured to: extract one or more features from the PPG data; and detect, based on the one or more features, the presence of the arrhythmia.

255. It is my opinion that the Shmueli-Osorio combination renders obvious element [26.0]. See element [7.0].

Q. Claim 30

[30.0] The non-transitory computer-readable storage medium of claim 25, the processing device further to receive the ECG data from the ECG sensor in response to receiving an indication of a user action.

256. It is my opinion that the Shmueli-Osorio combination renders obvious element [30.0]. See element [16.0].

XIII. ANALYSIS OF SHMUELI IN VIEW OF OSORIO AND LI 2012

257. For the reasons articulated in detail below, and based on my review of the ’731 patent, the file history, and the prior art references cited here, it is clear that a POSITA would have readily understood that the teachings of Shmueli in view of Osorio and Li 2012 provide all the elements of claims 3, 5, 6, 19, 21 and 22.

A. The Combination of Shmueli, Osorio and Li 2012

258. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. Then the combined device determines current HRV based on the heart rate information, determines the non-pathological HRV range based on the user's activity level and compares the HRV to the non-pathological HRV range to determine if there is an irregularity (e.g., arrhythmia), as taught by Osorio. APPLE-1005, Fig. 8 and [0077]-[0080] ("***the body index value may be heart rate and the BDV may be HRV***.").

259. By 2009, examples of known arrhythmia detection techniques include: neural networks, wavelet transforms, support vector machines, fuzzy logic and rule-based algorithms. APPLE-1040, p. 1928. According a 2011 article, most of the recent algorithms developed for detecting ECG anomalies (e.g., arrhythmia) are based in fuzzy logic and Neural Network techniques. APPLE-1041, p. 74. A POSITA would have understood that these algorithms are all machine learning algorithms. ; APPLE-1001, 9:61-66 (listing neural networks and support vector machines as exemplary machine learning algorithms). Thus, by the Critical Date, machine learning algorithms were a well-known and popular technique to detect arrhythmia based on heart rate data. *Id*.

260. In the Shmueli-Osorio-Li 2012 combination, a POSITA would have been motivated to employ a machine learning algorithm to detect arrhythmia based on its many advantages. For example, machine learning approaches offer superior performance when the inputs are complex, features of the input data cannot be readily discerned, or the relationships between input data are complex and nonlinear. Machine learning algorithms are sophisticated, automatic, and objective for analysis of high-dimensional and multimodal biomedical data. APPLE-1042, Abstract. Li 2012 also discloses that its machine learning algorithm can increase the detection accuracy by reducing false alarms. APPLE-1006, Abstract.

261. Osorio discloses detecting arrhythmia based on the motion sensor data, the body index and BDV. APPLE-1005, [0046] and [0071]. Osorio discloses that body index may be heart rate and the BDV may be HRV. APPLE-1004, [0080]. Osorio describes that the "BDV range determination module 260 may determine that the same BDV value (e.g., the same heart rate) in the same patient is either pathological or non-pathological based on the activity level, activity type, or other variables (e.g., fitness level)." APPLE-1005, [0036]. A POSITA would have been motivated to optimize this multifactor analysis in Osorio using a machine learning algorithm, in order to detect arrhythmia based on PPG data (and the heart rate and HRV derived therefrom) and the motion sensor data (and the activity level derived therefrom). A POSITA would have also been motivated to employ HRV

analysis because it is less affected by noise. APPLE-1039, p. 52 ("This is a more robust method since the R-R time intervals are less affected by the noise.").

262. In addition, after an ECG was measured following Shmueli's method, it is obvious for the combined device to detect arrhythmia using a machine learning algorithm based on the PPG data (and the heart rate and HRV derived therefrom), motion sensor data (and the activity level derived therefrom) and ECG data. Shmueli discloses "[o]ptionally but preferably the software program proceeds to element 50 to search for correlations between the SpO2 signal and the ECG signal ***to produce new detection parameters, or modify existing detection parameters, so as to enhance the detection algorithms of the irregular heart conditions***." APPLE-13:16-19. A POSITA would have understood that this disclosure refers to machine learning, which "focuses on algorithms capable of learning and/or adapting their structure (e.g., parameters) based on a set of observed data." APPLE-1042, p. 538;

263. A POSITA would also have had a reasonable expectation of success in using a machine learning algorithm to detect arrhythmia in this way. For example, Li 2012 discloses detecting arrhythmia based on PPG and ECG data and demonstrates that its machine learning algorithm can reduce false alarm by more than 30% (29.84% on training, 30.46% on test data) with a true alarm suppression rate below 1%. APPLE-1006, p. 7 and Table 6. Tsipouras 2004 discloses detecting

arrhythmia by training a machine learning algorithm (e.g., neural networks) with HRV data. APPLE-1012, Abstract. Tavassoli 2012 also discloses detecting arrhythmia by training a machine learning algorithm with HRV and ECG data. APPLE-1038, Abstract.

264. Thus, in the Shmueli-Osorio-Li 2012 combination, Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. Then the combined device determines current HRV based on the heart rate information (from the PPG data), and detects arrhythmia ***using a machine learning algorithm*** based on the PPG data, heart rate, HRV, motion sensor data and activity level.

265. Alternatively or in combination, in the Shmueli-Osorio-Li 2012 combination, upon detection of the irregularity (e.g., arrhythmia), the combined device notifies the user to take an ECG measurement and detects arrhythmia ***using a machine learning algorithm*** based on the PPG data, heart rate, HRV, motion sensor data, activity level and the ECG data. APPLE-1006, Abstract; APPLE-1004, Fig. 7 and 12:6-30.

B. Claim 3

[3.0] The smart watch of claim 2, wherein to detect the presence of the arrhythmia, the processing device is configured to input the PPG data into a machine learning algorithm trained to detect arrhythmias.

266. It is my opinion that the Shmueli-Osorio-Li 2012 combination renders

obvious element [3.0].

267. As discussed above in Section XIII.A, in the Shmueli-Osorio-Li 2012 combination, Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. Then the combined device determines current HRV based on the heart rate information (from the PPG data) and detects arrhythmia ***using a machine learning algorithm*** based on the PPG data, heart rate, HRV, motion sensor data and activity level. It would have been obvious that the processing device is configured to input the PPG data into a machine learning algorithm trained to detect arrhythmias. Thus, the Shmueli-Osorio-Li 2012 combination renders obvious [3.0].

268. Alternatively or in combination, in the Shmueli-Osorio-Li 2012 combination, upon detection of the irregularity (e.g., arrhythmia), the combined device notifies the user to take an ECG measurement and detects arrhythmia ***using a machine learning algorithm*** based on the PPG data, heart rate, HRV, motion sensor data, activity level and the ECG data. APPLE-1006, Abstract; APPLE-1004, Fig. 7 and 12:6-30;

C. Claim 5

[5.0] The smart watch of claim 4, wherein to detect the presence of the arrhythmia, the processing device is configured to input the HRV data into a machine learning algorithm trained to detect arrhythmias.

269. It is my opinion that the Shmueli-Osorio-Li 2012 combination renders

obvious element [5.0].

270. Osorio discloses detecting arrhythmia based on the motion sensor data, the body index and BDV. APPLE-1005, [0046] and [0071]. Osorio discloses that body index may be heart rate and the BDV may be HRV. APPLE-1004, [0080]. Osorio describes that the "BDV range determination module 260 may determine that the same BDV value (e.g., the same heart rate) in the same patient is either pathological or non-pathological based on the activity level, activity type, or other variables (e.g., fitness level)." APPLE-1005, [0036]. A POSITA would have been motivated to optimize this multifactor analysis in Osorio using a machine learning algorithm, in order to detect arrhythmia based on PPG data (and the heart rate and HRV derived therefrom) and the motion sensor data (and the activity level derived therefrom). A POSITA would have also been motivated to employ HRV analysis because it is less affected by noise. APPLE-1039, p. 52.

271. As discussed above in Section XIII.A, in the Shmueli-Osorio-Li 2012 combination, Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. Then the combined device determines current HRV based on the heart rate information (from the PPG data) and detects arrhythmia ***using a machine learning algorithm*** based on the PPG data, heart rate, HRV, motion sensor data and activity level. It would have been obvious that the processing device is configured to input the

HRV data into a machine learning algorithm trained to detect arrhythmias.Thus, the Shmueli-Osorio-Li 2012 combination renders obvious [5.0].

272. Alternatively or in combination, in the Shmueli-Osorio-Li 2012 combination, upon detection of the irregularity (e.g., arrhythmia), the combined device notifies the user to take an ECG measurement and detects arrhythmia ***using a machine learning algorithm*** based on the PPG data, heart rate, HRV, motion sensor data, activity level and the ECG data. APPLE-1006, Abstract; APPLE-1004, Fig. 7 and 12:6-30;

D. Claim 6

[6.0] The smart watch of claim 5, wherein to detect the presence of the arrhythmia, the processing device is further configured to input the motion sensor data with the HRV data into the machine learning algorithm trained to detect arrhythmias.

273. It is my opinion that the Shmueli-Osorio-Li 2012 combination renders obvious element [6.0].

274. Osorio discloses detecting arrhythmia based on the motion sensor data, the body index and BDV. APPLE-1005, [0046] and [0071]. Osorio discloses that body index may be heart rate and the BDV may be HRV. APPLE-1004, [0080]. Osorio describes that the "BDV range determination module 260 may determine that the same BDV value (e.g., the same heart rate) in the same patient is either pathological or non-pathological based on the activity level, activity type, or other variables (e.g., fitness level)." APPLE-1005, [0036]. A POSITA would have

been motivated to optimize this multifactor analysis in Osorio using a machine learning algorithm, in order to detect arrhythmia based on PPG data (and the heart rate and HRV derived therefrom) and the motion sensor data (and the activity level derived therefrom). A POSITA would have also been motivated to employ HRV analysis because it is less affected by noise. APPLE-1039, p. 52.

275. As discussed above in Section XIII.A, in the Shmueli-Osorio-Li 2012 combination, Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. Then the combined device determines current HRV based on the heart rate information (from the PPG data) and detects arrhythmia ***using a machine learning algorithm*** based on the PPG data, heart rate, HRV, motion sensor data and activity level. It would have been obvious that the processing device is configured to input the motion sensor data and the HRV data into a machine learning algorithm trained to detect arrhythmias. Thus, the Shmueli-Osorio-Li 2012 combination renders obvious [3.0].

276. Alternatively or in combination, in the Shmueli-Osorio-Li 2012 combination, upon detection of the irregularity (e.g., arrhythmia), the combined device notifies the user to take an ECG measurement and detects arrhythmia ***using a machine learning algorithm*** based on the PPG data, heart rate, HRV, motion sensor data, activity level and the ECG data. APPLE-1006, Abstract; APPLE-

1004, Fig. 7 and 12:6-30.

E. Claim 19

[19.0] The method of claim 18, wherein detecting the presence of the arrhythmia comprises inputting the PPG data into a machine learning algorithm trained to detect arrhythmias.

277. It is my opinion that the Shmueli-Osorio-Li 2012 combination renders obvious element [19.0]. *See* element [3.0].

F. Claim 21

[21.0] The method of claim 20, wherein detecting the presence of the arrhythmia comprises inputting the HRV data into a machine learning algorithm trained to detect arrhythmias.

278. It is my opinion that the Shmueli-Osorio-Li 2012 combination renders obvious element [21.0]. *See* element [5.0].

G. Claim 22

[22.0] The method of claim 21, wherein detecting the presence of the arrhythmia comprises inputting the motion sensor data with the HRV data into the machine learning algorithm trained to detect arrhythmias.

279. It is my opinion that the Shmueli-Osorio-Li 2012 combination renders obvious element [22.0]. *See* element [6.0].

XIV. ANALYSIS OF SHMUELI IN VIEW OF OSORIO AND KLEIGER 2005

280. For the reasons articulated in detail below, and based on my review of the ’731 patent, the file history, and the prior art references cited here, it is clear that a POSITA would have readily understood that the teachings of Shmueli in view of Osorio and Kleiger 2005 provide all the elements of claims 8-11 and 27-

29.

A. The Combination of Shmueli, Osorio and Kleiger 2005

281. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Osorio's motion sensor (e.g., accelerometer) is added to Shmueli's device to detect a user's activity level, which in combination with PPG data is used to detect arrhythmia with increased accuracy based on activity level. APPLE-1005, [0029]. In the Shmueli-Osorio combination, Shmueli's PPG sensor is used to determine heart rate information, and Osorio's motion sensor is used to determine the user's activity level. Then, ***the combined device determines HRV based on the heart rate information*** and determines the non-pathological HRV range based on the user's activity level and compares the HRV to the non-pathological HRV range to determine the presence of arrhythmia, as taught by Osorio. APPLE-1005, Fig. 8 and [0077]-[0080] ("***the body index value may be heart rate and the BDV may be HRV***.").

282. Thus, Shmueli and Osorio determine HRV based on the heart rate information. As discussed in Section X.D, Kleiger provides a detailed disclosure of how to determine HRV based on heart rate information. Since Shmueli and Osorio do not provide a detailed disclosure on how to determine HRV based on the heart rate information, a POSITA would have been motivated to look to Kleiger 2005 for such details. In the Shmueli-Osorio-Kleiger 2005 combination, the

combined device applies the common HRV measures described in Kleiger 2005 to determine HRV from the heart rate information. A POSITA would have had a reasonable expectation of success because Kleiger 2005's HRV measures were standard techniques that had been used in the field.

283. Thus, in the Shmueli-Osorio-Kleiger 2005 combination, the combined device determines HRV based on the heart rate information from the PPG data using the HRV measures described in Kleiger 2005.

B. Claim 8

[8.0] The smart watch of claim 7, wherein the one or more features correspond to an HRV signal analyzed in a time domain.

284. It is my opinion that the Shmueli-Osorio-Kleiger 2005 combination renders obvious element [8.0].

285. As discussed above in Section XIV.A, in the Shmueli-Osorio-Kleiger 2005 combination, the combined device determines HRV based on the heart rate information from the PPG data using the HRV measures described in Kleiger 2005.

286. Kleiger 2005 discloses extracting HRV from the heart rate information using time domain measures of HRV (HRV signal analyzed in a time domain). APPLE-1033, p. 88 ("In time domain analysis, the intervals between adjacent normal R waves (NN intervals) are measured over the period of recording."). Thus, in the Shmueli-Osorio-Kleiger 2005 combination, it would

have been obvious that the combined device determines HRV based on HRV signal analyzed in a time domain. Thus, the Shmueli-Osorio-Kleiger 2005 combination renders obvious [8.0].

C. Claim 9

[9.0] The smart watch of claim 7, wherein the one or more features comprise a nonlinear transform of R-R ratio or R-R ratio statistics with an adaptive weighting factor.

287. It is my opinion that the Shmueli-Osorio-Kleiger 2005 combination renders obvious element [9.0].

288. The '731 patent does not define the term "R-R ratio." Although this term is not defined, a POSITA would have understood that term to refer to the ratio of consecutive RR intervals, or the ratio of one RR interval versus the previous RR interval, and that this is a measure of RR interval fluctuations. Kleiger 2005 discloses that the Poincare graph plots ***each RR interval as a function of the next RR interval***. APPLE-1033, p. 92. Kleiger 2005 also explains that the Poincare plot is a ***nonlinear*** measure of the ***RR interval fluctuations***. *Id*., Fig. 2. Based on this disclosure and a POSITA's knowledge, training, and experience in the field as of the Critical Date, a POSITA would have understood that the Poincare plot involves a nonlinear transform of R-R ratio (e.g., a ratio of consecutive RR intervals).

289. As discussed above in Section XIV.A, in the Shmueli-Osorio-Kleiger 2005 combination, the combined device determines HRV based on the heart rate

information from the PPG data using the HRV measures described in Kleiger 2005. Kleiger 2005 discloses extracting HRV from the heart rate information using nonlinear measures of HRV including the Poincare plot. APPLE-1033, pp. 91-92 ("The Poincare graph plots each R-R interval as a function of the next R-R interval (Fig. 2, top panel) and provides an excellent way to visualize patterns of R-R itnervals."). In the Shmueli-Osorio-Kleiger 2005 combination, it would have been obvious that the combined device determines HRV based on the Poincare plot. Thus, the Shmueli-Osorio-Kleiger 2005 combination renders obvious [9.0].

D. Claim 10

[10.0] The smart watch of claim 7, wherein the one or more features are features of an HRV signal analyzed geometrically.

290. It is my opinion that the Shmueli-Osorio-Kleiger 2005 combination renders obvious element [10.0].

291. As discussed above in Section XIV.A, in the Shmueli-Osorio-Kleiger 2005 combination, the combined device determines HRV based on the heart rate information from the PPG data using the HRV measures described in Kleiger 2005.

292. Kleiger 2005 discloses extracting HRV from the heart rate information using geometric measures (HRV signal analyzed geometrically). APPLE-1033, p. 91 ("Heart rate variability triangular index, a geometric measure of HRV, has been used extensively by investigators at St. George's Hospiral in

London."). Thus, in the Shmueli-Osorio-Kleiger 2005 combination, it would have been obvious that the combined device determines HRV based on HRV signal analyzed geometrically. Thus, the Shmueli-Osorio-Kleiger 2005 combination renders obvious [10.0].

E. Claim 11

[11.0] The smart watch of claim 7, wherein the one or more features are features of an HRV signal analyzed in the frequency domain.

293. It is my opinion that the Shmueli-Osorio-Kleiger 2005 combination renders obvious element [11.0].

294. As discussed above in Section XIV.A, in the Shmueli-Osorio-Kleiger 2005 combination, the combined device determines HRV based on the heart rate information from the PPG data using the HRV measures described in Kleiger 2005.

295. Kleiger 2005 discloses extracting HRV from the heart rate information using spectral or frequency domain measures (HRV signal analyzed in the frequency domain). APPLE-1033, pp. 89-91 ("Either fast Fourier transformation or autoregression techniques can be used to quantify cyclic fluctuations of R-R intervals."). Thus, in the Shmueli-Osorio-Kleiger 2005 combination, it would have been obvious that the combined device determines HRV based on HRV signal analyzed in the frequency domain. Thus, the Shmueli-Osorio-Kleiger 2005 combination renders obvious [11.0].

F. Claim 27

[27.0] The non-transitory computer-readable storage medium of claim 26, wherein the one or more features correspond to an HRV signal analyzed in a time domain.

296. It is my opinion that the Shmueli-Osorio-Kleiger 2005 combination renders obvious element [27.0]. See element [8.0].

G. Claim 28

[28.0] The non-transitory computer-readable storage medium of claim 26, wherein the one or more features comprise a nonlinear transform of R-R ratio or R-R ratio statistics with an adaptive weighting factor.

297. It is my opinion that the Shmueli-Osorio-Kleiger 2005 combination renders obvious element [28.0]. See element [9.0].

H. Claim 29

[29.0] The non-transitory computer-readable storage medium of claim 26, wherein the one or more features are features of an HRV signal analyzed geometrically or in the frequency domain.

298. It is my opinion that the Shmueli-Osorio-Kleiger 2005 combination renders obvious element [29.0]. See element [10.0].

XV. ANALYSIS OF SHMUELI (OR SHMUELI AND OSORIO) IN VIEW OF CHAN

299. For the reasons articulated in detail below, and based on my review of the ’731 patent, the file history, and the prior art references cited here, it is clear that a POSITA would have readily understood that the teachings of Shmueli in view of Chan, or Shmueli in view of Osorio and Chan provide all the elements of

claim 15.

A. The Combination of Shmueli (or Shmueli and Osorio) and Chan

300. As discussed above in Section X.A and Section A.E, both Shmueli and Chan disclose similar wrist-worn devices that monitor the user's ECG in order to detect irregular heart conditions, such as arrhythmia. As discussed above in Section XII.A, in the Shmueli-Osorio combination, Shmueli's device is modified by incorporating Osorio's motion sensor and activity level analysis.

301. As discussed above in Section X.E, Chan discloses a "wristwatch worn by a user for measuring a three-lead ECG." APPLE-1048, Abstract. Figs. 1A and 1B show front and back views of Chan's device. APPLE-1048, 2:43-49. In the backside 1 of the watch, an electrode 3 is inserted for touching the hand that wears the watch. *Id*. The frontside 2 of the watch includes electrode 4 and electrode 6 for fingers from the other hand to press on. *Id*. A display 7, such as a liquid crystal display (LCD), is on the frontside 2 of the watch. *Id.* The display 7 can demonstrate in text 15, which includes time, heart rate, condition (normal or arrhythmia), and graph/animation, an event 13 and ECG waveforms 14. *Id*.

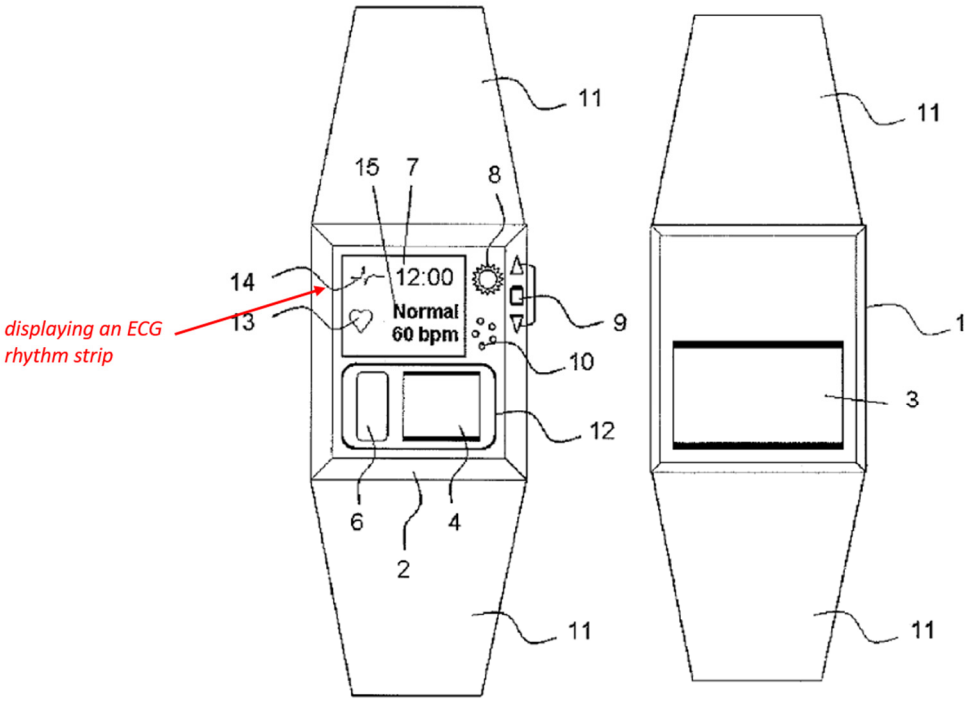
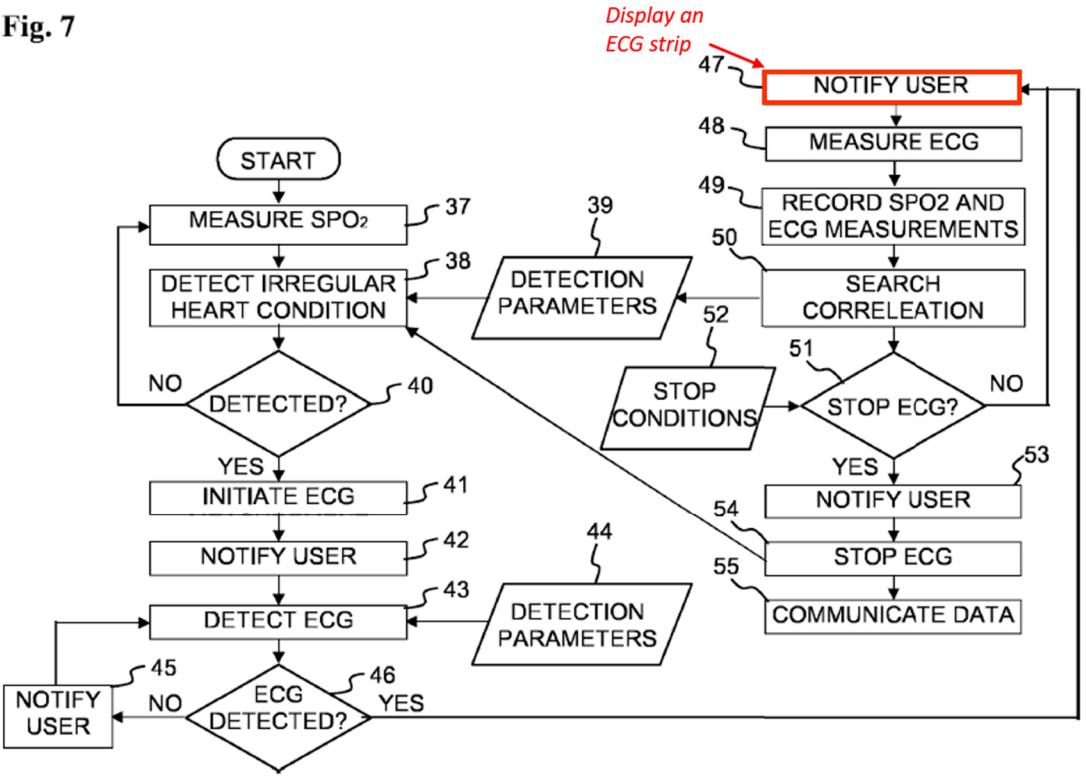


FIG.1A FIG.1B

APPLE-1045, Figs. 1A and 1B (annotated).

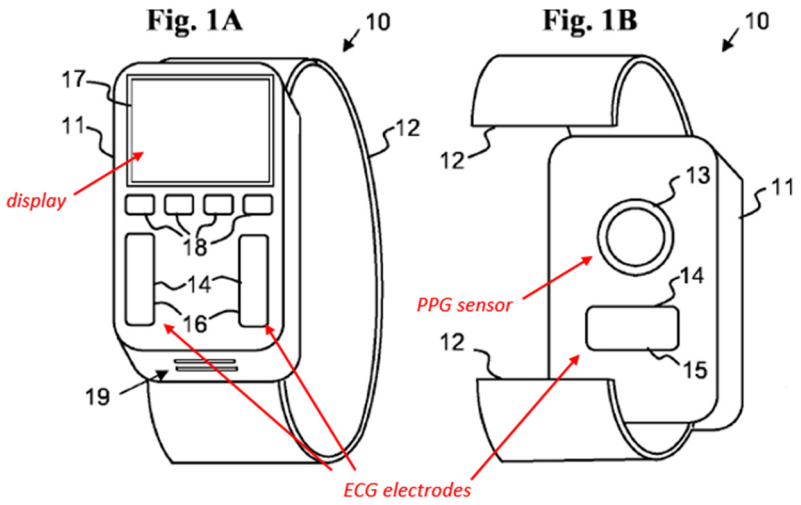
302. As discussed above in Section X.A, Shmueli's device also includes an ECG sensor and a display. Shmueli's device first detects arrhythmia based on SpO2 measurement. APPLE-1004, Abstract and 7:25-31. If the SpO2 measurement indicates arrhythmia, Shmueli's device then takes an ECG measurement to confirm the arrhythmia detection and notifies the user of the detected ECG. *Id*. Fig. 7 shows an example of Shmueli's method:

Fig. 7



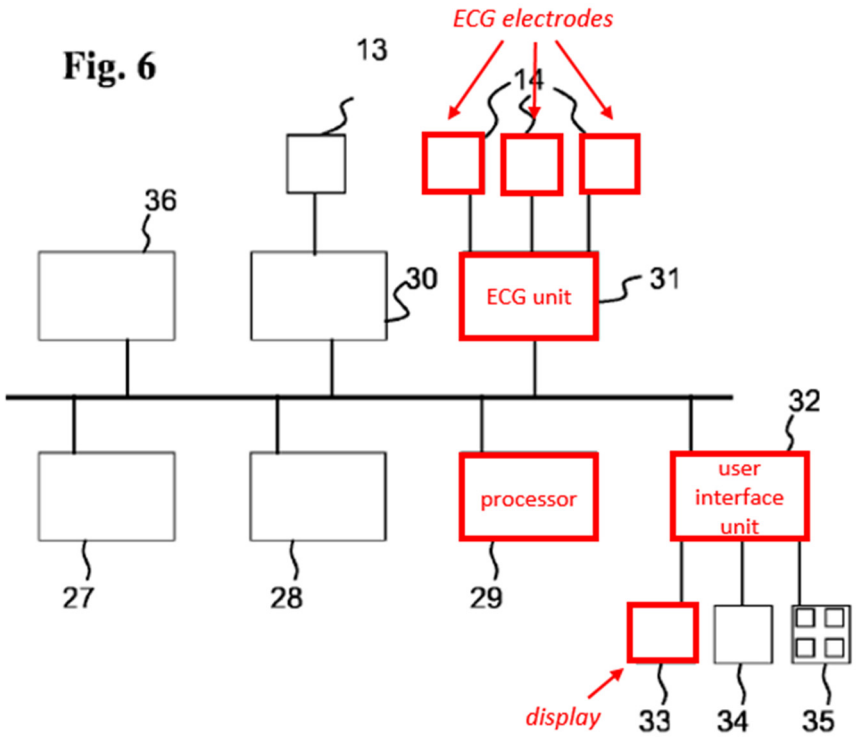
APPLE-1004, Fig. 7 (annotated).

303. Similar to Chan, Shmueli also discloses that the wrist-worn device includes a display. APPLE-1004, APPLE-1004, 9:26-28, 11:10-15 ("preferably containing output devices such as a display 33"), Figs. 1A and 6.



APPLE-1004, Figs. 1A and 1B (annotated).

304. As shown in Fig. 6 below, Shmueli's heart monitoring device includes "a memory unit 28, a processor 29, an oximetry measuring unit 30 with the oximetry sensor 13, an ECG measuring unit 31 with three ECG contact sensors 14, **a user interface unit 32 preferably containing output devices such as a display 33**." APPLE-1004, 11:10-15.



APPLE-1004, Fig. 6 (annotated).

305. Shmueli further discloses that "[t]he notifications to the user, such as the various notifications to start the ECG measurement (element 42), notifications of ongoing ECG measurement (element 47), and notification that the ECG measurement has stopped (element 53) may be ***visual*** and/or audible, and/or

graphic, and/or ***textual***, and/or using sound, and/or using speech, and/or using vibration, etc." APPLE-1004, 14:4-8. Shmueli further discloses that "[t]he notifications to the user, such as the various notifications to start the ECG measurement (element 42), ***notifications of ongoing ECG measurement (element 47),*** and ***notification that the ECG measurement has stopped (element 53)*** may be ***visual*** and/or audible, and/or ***graphic***, and/or textual..." APPLE-1004, 14:4-8. A POSITA would have understood that there are only a finite number of ways to notify the user of "ongoing ECG measurement" and "that the ECG measurement has stopped." In view of Chan, a POSITA would have recognized that one obvious method to provide ECG information is to display the ECG rhythm strip. A POSITA would have been motivated to display the ECG waveforms because it allows the user to see the ***ongoing ECG measurement (element 47)*** in real time, and also get notified ***when the ECG measurement has stopped (element 53)***.

306. In addition, although Shmueli does not contain a detailed disclosure on what information is provided on its display, a POSITA would have found it obvious to turn to Chan for such details because Shmueli and Chan describes similar wristworn devices that monitor ECG and detect irregular heart conditions, such as arrhythmia. Indeed, Shmueli discloses that its "invention is capable of other embodiments or of being practiced or carried out in various ways." APPLE-1004, 7:16-17.

307. In the Shmueli-Chan or Shmueli-Osorio-Chan combination, the combined device employs Chan's display that demonstrates in text, information including time, heart rate, condition (normal or arrhythmia), and also demonstrates in graph/animation, information including ECG waveforms. APPLE-1048, 2:43-49;

B. Claim 15

[15.0] The smart watch of claim 1, the processing device further configured to display an ECG rhythm strip from the ECG data.

308. It is my opinion that the Shmueli-Chan combination or Shmueli-Osorio-Chan combination renders obvious element [15.0].

309. As shown in Fig. 1A, Chan discloses that its display 7 can demonstrate in text 15, which includes time, heart rate, condition (normal or arrhythmia), and graph/animation, an event 13 and ***ECG waveforms 14***. APPLE-1048, 2:43-49.

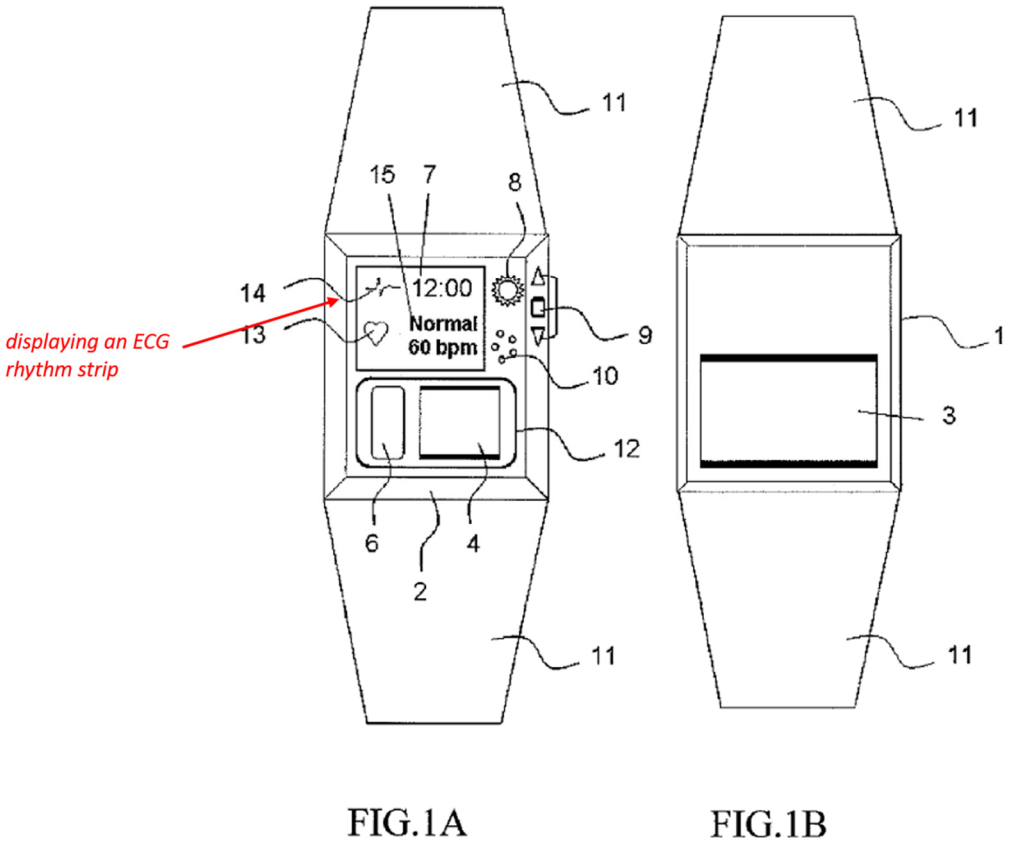


FIG.1A FIG.1B

APPLE-1045, Figs. 1A and 1B (annotated).

310. Although the '731 patent does not define the term "ECG rhythm strip," a POSITA would have understood the term "ECG rhythm strip" to refer to ECG waveforms.

311. As discussed above in Section XV.A, in the Shmueli-Chan combination or Shmueli-Osorio-Chan, the combined device employs Chan's display that demonstrates, in graph/animation, ***ECG waveforms***. It would have been obvious that Chan's EGG waveforms include an ECG rhythm strip from the ECG data within the meaning of the '731 patent. Thus, the Shmueli-Chan combination renders obvious [15.0].

XVI. CONCLUSION

312. The findings and opinions set forth in this declaration are based on my work and examinations to date.

313. I may continue my examinations. I may also receive additional documentation and other factual evidence over the course of this IPR that will allow me to supplement and/or refine my opinions. I reserve the right to add to, alter, or delete my opinions and my declaration upon discovery of any additional information. I reserve the right to make such changes as may be deemed necessary.

314. In signing this declaration, I recognize that the declaration will be filed as evidence in an IPR before the PTAB. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

315. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: June 4 2021 By: Bernard Chaitman MD

Dr. Bernard R. Chaitman
St. Louis, Missouri

02/09/2021

Bernard Chaitman MD

Curriculum Vitae

Bernard R. Chaitman, M.D.

St. Louis University Core ECG Laboratory
1034 S. Brentwood Blvd.
Suite 1550
St. Louis, MO 63117

Institutional Contact Information
Work: (314) 725-4668
Fax: (314) 725-2171
E-mail: bernard.chaitman@health.slu.edu
Personal Contact Information
Home: (314) 422-2096 (Mobile)
Fax: (314) 993-8539
E-mail: chaitman@swbell.net

Birth: Detroit, Michigan
December 23, 1943

Marital Status: Married, 3 children

Education: Premedical: McGill University
Montreal, Quebec, B.Sc., 1965
Medical: McGill University
Montreal, Quebec, M.D., C.M., 1969

Residency: Internal Medicine: McGill University
Royal Victoria Hospital
Montreal, Quebec, 1969-1972

Specialty: Cardiology: University of Oregon
University of Oregon Health Sciences Center
Portland, Oregon, 1972-1974

University of Montreal
Montreal Heart Institute
Montreal, Quebec, 1974-1975

Citizenship: United States/Canadian (dual)

Current Position: Emeritus Professor of Medicine
Director of Cardiovascular Research
St Louis University School of Medicine

Academic Appointments:

Saint Louis University School of Medicine	
Director, Cardiovascular Research	2000-
Medical Director, Core ECG/MI Classification Laboratory	1989-
Director, Division of Cardiology	1989-2000
Professor of Medicine	1983-2018
Professor Emeritus/Adjunct Professor	2018
University of Montreal Medical School	
Associate Professor of Medicine	1980-1983
Assistant Professor of Medicine	1976-1979

Hospital Appointments:

Saint Louis University Hospital:	
Attending Staff	1983-
Director of Exercise and Nuclear Cardiology Laboratories	1983-1989
Montreal Heart Institute:	
Director of Noninvasive Laboratory	1979-1983
Attending Staff	1976-1983

University/Hospital:

The Department of Internal Medicine Promotions and Tenure Committee	2012-
Executive Medical Director, *SoLUtions*, a Clinical Research Organization	2005-2010
Chairman, Search Committee, Chief of Cardiology, St. Louis University	2009-2010
SLU Cardiovascular Institute Planning Committee, Director	1999-
SLUCare New Business Initiatives Committee	1996-1997
Managed Care Contract Committee	1995-1997
Continuing Medical Education Advisory Committee Member	1995-1999
Business Plan Development Committee	1995
Search Committee Member, Chair of Opthamology	1997
Search Committee Member, Chief of Cardiology, Cardinal Glennon Hospital	1993-94
Clinical Service Database Planning Committee	1993-1994
Veterans Administration School of Medicine; Internal Medicine Shared Resource Committee	1989-1996
Internal Medicine Executive Committee Member	1989-2000
Department Design Team for Ambulatory Care Building	1991-1992
University Ad hoc Committee of the Educational Policy Committee	1990-1991
Search Committee Member, Physiology Chair	1988-1989
Radioactive Drug Research Committee Member	1987-1989
Chairman, Biomedical/Instrumentation Committee	1987
Committee Member, Quality Assurance Committee	1987
Liaison Committee on Medical Education	1986
University Hospital Forms Committee	1985

Professional Societies (Current and Former*):

Fellow of the American College of Cardiology

Fellow of the Clinical Council of the AHA
Association of University Cardiologists*
American Society of Nuclear Cardiology*
American Society of Echocardiography*
President, St. Louis Greater Division of the American Heart Association 1998-2000
Fellow of the Royal College of Physicians and Surgeons of Canada*
Fellow, Academy of Science of St. Louis
President, St. Louis Cardiac Society 1989-90

Board Certificates:

American Board of Internal Medicine	1973
American Board of Cardiovascular Disease	1975
Royal College of Physicians and Surgeons of Canada	1976
College of Physicians and Surgeons of Quebec	1975
National Board of Echocardiography	2001-2011
Diplomate of the Certification Board of Cardiovascular Computed Tomography	2009-2019

License: National Board of Medical Examiners 1970 (#103299)
Medical Council of Canada 1970 (#29980)
State of Missouri (#R8C62) (Active)
State of Florida (#ME120638) (Active)
State of Illinois (#036-074342) (Inactive)
State of New York (#246687) (Inactive)

Certifications: Good Clinical Practice – October, 2019
Conflict of Interest – August, 2019
Advance Cardiac Life Support – 1/6/21-1/6/23
Saint Louis University Annual Compliance Update
Fraud, Waste and Abuse –
Saint Louis University Information Security Awareness –
Saint Louis University Moderate Sedation

NIH Related Activities:

Research Grant Review Committees:

NHLBI NIH Challenge Grants in Health and Science Research (part of the American Recovery and Reinvestment Act of 2009), Grant Review Committee	2009
NIH/NHLBI Cardiothoracic Network Cardiopulmonary Exercise Core Lab Review Committee	2008
NHLBI Loan Repayment Program Review Committee for Health Careers in Research	2005
NHLBI Study Section: Clinical Trial Review Committee	1998-2002
NIH Ad Hoc Review Committee Member for the RFA applications Pathologic Effects of Impaired Myocardial function in Older Persons	1993
NHLBI Supplemental Scor Grant Review Committee	1987
NHLBI Scor Grant Review Committee	1986

Safety and Data Monitoring Board:

Safety Monitoring Committee for the National Institutes of Allergy and Infectious Diseases, National Institutes of Health, Division of Microbiology and Infectious Diseases study, "Randomized, Placebo-Controlled, Double-Blind, Dose-Escalation Phase I Study of the Safety, Tolerability and Pharmacokinetics of a Single Intravenous Dose of ETI-204 (Anthim^{TM})"	2008-09
Chairman DSMB, Women's Angiographic Vitamin and Estrogen (WAVE) Trial Protocol Review Committee, AC 11023, Award #NO1-HV-68165, D. Waters, PI.	1997-2004
Chairman, Data Safety and Monitoring Board for the Multicenter Unsustained Tachycardia Trial (MUSTT) A. Buxton, PI.	1992-1999
Chairman, Data Safety and Monitoring Board for "A Vascular Basis for the Treatment of Ischemia" Study, P. Stone, PI.	1996-

Clinical Event Committee Activity-Chairman (NIH unless otherwise specified):

WARRIOR Trial; Department of Defense
MINT 2 Trial
ISCHEMIA Trial
ISCHEMIA CKD Trial
AIM HIGH Trial
BARI-2 Diabetes Trial (ACS classification)
BARI Trial; Committee member
FOCUS Trial
MINT Trial
COURAGE (VA/MRC)
RESCUE CCTA Trial (ACRIN); Committee member

NIH Funded Activities:

Clinical Trials:

NHLBI, 1U01HL117904-01 International Study of Comparative Health Effectiveness with Medical and Invasive Approaches (ISCHEMIA) - CKD, Core Event and Rest ECG Analysis Laboratory	2013-2019
NHLBI, 1U01HL105462-01 International Study of Comparative Health Effectiveness with Medical and Invasive Approaches **(**ISCHEMIA), Core Event and Rest ECG Analysis Laboratory	2011-2019
NHLBI, SU01HL105561-03 International Study of Comparative Health Effectiveness with Medical and Invasive Approaches **(**ISCHEMIA) ETT, Core Event and Rest ECG Analysis Laboratory	2014-2019
NHLBI, 1U01HL133817-02 Myocardial Ischemia aNd Transfusion II (MINT) Trial	2016-2020
NHLBI, 1RC2HL101458 Myocardial Ischemia aNd Transfusion (MINT) Trial, A Pilot Study	2009-2012
Fred Hutchinson Cancer Center: HTVN and IAVI Vaccine Trials	2008-2018
Division of Microbiology and Infectious Diseases (NIAID/NIH): DMID	2009-
US Military HIV Research Programs	2009

NHLBI, U01HL081616-01; AIM HIGH Core Event and Rest ECG Analysis Laboratory, Executive Committee Member 2005-2011

NHLBI, U01HL073958-03S1 FOCUS Core Event and Rest ECG Analysis Laboratory, Executive Committee Member 2005-2009

NHLBI, NO1-RO1H1261746-01A1; BARI-2 Diabetes Trial Core ECG Laboratory, Executive Committee Member 2001-2009

NHLBI, NO1-HC-65149; Prevention of Events with Angiotensin Converting Enzyme Inhibitors (PEACE), PI; St. Louis University site; Multicenter Trial E. Braunwald, PI. 1997-2003

NHLBI, NO1-HV-18120; Asymptomatic Cardiac Ischemia Pilot (ACIP), Operations, Executive, Steering, and Publications Committees 1991-1993

NHLBI, RO1HL38504-03; Bypass Angioplasty Revascularization Investigation (BARI), Operations and Executive Committee Member; BARI Ancillary Study of Economic and Quality of Life 1987-1993

NHLBI, RO1; Thrombolysis in Acute Myocardial Infarction (TIMI) Phase III, PI; St. Louis University Site; Multicenter Trial (E. Braunwald, PI); Executive Committee and Steering Committee Member 1989-1991

NHLBI, Contract No. NO1-HV-68093; Thrombolysis in Acute Myocardial Infarction (TIMI II); PI, St. Louis University Site; Multicenter Trial (E. Braunwald, PI); Executive Committee Member, Steering Committee Member 1986-1989

NHLBI Coronary Artery Surgery Study (CASS), Co-Investigator, Executive Committee Member 1975-1988 1988-1992

Core Rest and Exercise ECG Laboratory:

NHLBI, 1U01HL117904-01 International Study of Comparative Health Effectiveness with Medical and Invasive Approaches (ISCHEMIA) - CKD Core Event and Rest ECG Analysis Laboratory 2013-2019

NHLBI, 1U01HL105462-01 International Study of Comparative Health Effectiveness with Medical and Invasive Approaches (ISCHEMIA), Core Event and Rest ECG Analysis Laboratory 2011-2019

NHLBI, SU01HL105561-03 International Study of Comparative Health Effectiveness with Medical and Invasive Approaches (ISCHEMIA) ETT, Core Event and Rest ECG Analysis Laboratory 2014-2019

NHLBI, 1RC2HL101458 Myocardial Ischemia aNd Transfusion (MINT) Trial: A Pilot Study, Core Event and Rest ECG Analysis Laboratory 2009-2012

NHLBI, U01HL081616-01 AIM HIGH Core Event and Rest ECG Analysis Lab 2005-2011

NHLBI, U01HL073958-03S1 FOCUS Core Event and Rest ECG Analysis Laboratory 2005-2009

NHLBI, NO1-RO1H1261746-01A1 BARI-2 Diabetes Trial Core ECG Laboratory 2001-2009

NHLBI, NO1-AG-6-2106 Dynamics of Health, Aging ECG Laboratory (NIH): and Body Composition (Health ABC). Core ECG Laboratory 1997-2004

NHLBI, N01-HC-55140, ENRICHD Core ECG Laboratory 1997-2001

NHLBI, RO1HL421245-04; BARI Core Rest Electrocardiogram and Exercise ECG Laboratory 1988-2001

NHLBI ACIP and PIMI Trial Core Rest and Exercise ECG Laboratory 1991-1994

NHLBI, RO1HL42419-03 TIMI Phase III A & B Core Rest and Exercise ECG Lab 1989-1993

NHLBI, TIMI II Core Exercise ECG Laboratory 1988-1989

Department of Defense Funded Activiies

Women's IschemiA TReatment Reduces Events In Non-ObstRuctive CAD (WARRIOR): CEC Chair — 2018-2024

Industry Sponsored Clinical Event Committee Work:
Chairman, CEC, Daiichi Sankyo Trials
Chairman, CEC, NovoNordisc Trials
Chairman, CEC, Relypsa Trials
Member, CEC, Merck Trials
Member, Jenssen (J&J) Trials
Chairman, CEC, Eli Lilly Trials
Chairman, CEC, Roche Trials
Chairman, CEC, Sanofi Aventis
Chair: CEC Bayer trials
Chairman, CEC, Sunovion Trials

Industry Sponsored Clinical DSMB Trials:
Chairman, DSMB, Relypsa Trial
Chairman, DSMB, Sanofi/Regeneron Trial
Member, Pfizer neuroscience trial
Chairman, DSMB, Atherogenics Trials
Chairman, DSMB, Sepracor Protocols
Chairman, DSMB, Pfizer Trials
Chairman, DSMB, Kendle International, Inc
Member, DSMB, Sanofi-Aventis Trials
Member OPUS TIMI 16 Trial

Core Rest and Exercise ECG Laboratory (other):

Women's IschemiA TReatment Reduces Events In Non-ObstRuctive CAD (WARRIOR): Department of Defense, CEC
Relypsa: Clinical Trials
NovoNordisk: Clinical Trials
Roche: Clinical Trials
COURAGE Trial: Evaluation of Aggressive Medical Therapy vs. Percutaneous Coronary Intervention: VA and MRC (Canada) clinical trial
Aventis: Clinical Trials
Pfizer: Clinical Trials
Bristol-Myers Squibb: Clinical Trials
Gilead/CV Therapeutics, Inc: Clinical Trials
Boston Scientific Scimed, Inc.: Clinical Trials
Schering-Plough: Clinical Trials
Eclipse Surgical Technologies, Inc.: Clinical Trials
Merck Pharmaceutical Research Group: Clinical Trials
Ohmeda, Inc.: Clinical Trials
Zeneca Pharmaceuticals: Clinical Trials
Berlex Pharmaceuticals: Clinical Trials
Gensia, Inc.: Clinical Trials
Genentech, Inc.: Clinical Trials
Smith Kline & French, Inc.: Clinical Trials

Ciba-Geigy Pharmaceuticals, Inc.: Clinical Trials
Biogen: Clinical Trials
Bayer Pharmaceuticals: Clinical Trials
Marshfield Medical Research Foundation, PI: Myocardial Ischemia/Infarct Classification Laboratory - Perioperative Myocardial Infarction Studies 1992-1995

Previous Funding, PI Unless Otherwise Specified:

CO Exposure in Cardiac Arrhythmias: Health Effects Institute (PI), Boston, MA Award #87-8 1987-1989
Ticlopidine; Prevention of Restenosis Post PTCA, Syntex Research, Palo Alto, CA 1984-1987
CO Exposure in CAD: Health Effects Institute, Boston, MA 1984-1987
Evaluation of Noninvasive techniques to diagnose CAD 1980-1983
Evaluation of the exercise polarcardiogram Canadian Heart Foundation 1980-1983
Prospective evaluation of Carpentier-Edwards porcine valves, Edwards Laboratory 1977-1983

Veterans Affairs Activities:

Safety and Data Monitoring Board, Department of Veterans Affairs, Cooperative Studies in Health Services ("The Diagnostic and Prognostic Value of the Computerized Exercise ECG") 1994-1997
Veterans Affairs Cardiovascular Disease Merit Review Board 1985-1987

Additional Research Grant Review Committees:

U.S. Agency for Health Care Policy and Research: AdhocReview Committee; Evaluation of the Ambulatory Ischemic Heart Disease Port 1994
Peer Reviewer, Clinical Practice Guideline on the Definition and Management of Unstable Angina (for Duke University and the U.S. Agency for Health Care Policy and Research) 1993-
American Heart Association, Missouri Affiliate 1984-1987
Cardiovascular Disease Section; National Veterans Administrative Merit Review Board 1984-1987
Medical Research Council of Canada 1979-1981
Canadian Heart Foundation 1979-1981

Committee Membership:

FDA/ACCF/AHA Cardiovascular Endpoints Data Standards Writing Committee 2013-
FDA Working Group on Clinical Event Committee Definitions and Processes, ACS Subcommittee member 2009-
Chairman, ECG working Group European Society of Cardiology / American Heart Association / American College of Cardiology / World Federation of Cardiology Task Force to prepare document on the Universal Definition of Myocardial Infarction 2007-
ACC Bethesda Conference Committee to rewrite the Sudden Cardiac Death in Athletes Report 2003
American College of Cardiology/American Heart Association/ European Society of Cardiology; Ventricular Arrhythmias and Sudden Cardiac Death Guidelines 2003

Writing Committee

FDA ad-hoc Committee on Electronic ECG Formatting - Aware Citation from FDA	2003
American Heart Association Council on Clinical Cardiology, Nominating Committee	2001-2003
American Heart Association Council on Clinical Cardiology, Scientific Program Committee	2001-2004
American College of Cardiology Foundation; Writing Committee for Task Force 6 to develop Concensus Report on Coronary Artery Disease	2003-2004
American College of Cardiology/American Heart Association Joint Subcommittee Writing Group to Revise the Report of the 1996 Exercise Test Guidelines	2000
American College of Cardiology Writing Group to Revise the Report of the 1995 Core Cardiology Training Symposium (COCATS)	2000
American College of Cardiology/American Heart Association Joint Subcommittee Writing Group to Revise the Report of the Guidelines for Evaluation of Patients Considered for Noncardiac Surgery	2000
Executive Committee Member, AHA Council on Clinical Cardiology	1998-2001
AHA Council on Clinical Cardiology: Chairman of Committee for Exercise, Cardiac Rehabilitation and Prevention	1998-2001
American College of Cardiology, Chairman, Constitution and Bylaws Committee	1998-2001
American College of Cardiology, Training Directors Committee	1991-1997
International Society for Electrocardiology	1997-
Accreditation and Curriculum Sub-Council, Association of Subspecialty Professors	1994-1997
Vice Chairman of the Committee for Exercise and Cardiac Rehabilitation; American Heart Association Council on Clinical Cardiology	1993-1998
American Heart Association Missouri Chapter, Vice-President and Board of Directors	1993-1995
American College of Cardiology, Chairman Nominating Committee, Missouri Chapter	1993
Regional Councilor, State of Missouri Chapter, American College of Cardiology	1992
ACGME: Cardiovascular Precertification Review Committee	1990-1996
Governor's Advisory Group, American College of Cardiology, State of Missouri	1989
European Society of Cardiology Working Group on Exercise Physiology, Physiopathology & Electrocardiography	1986-
AHA Abstract Review Committee, Scientific Sessions	1978-1979, 1984-present
American College of Cardiology Scientific Sessions Abstract Review Committee	1983-present
Abstract Review Committee, Scientific Sessions, Canadian Cardiovascular Society	1982
Scientific Review Committee, Consultant to International Symposium on Cardiac Bioprosthesis	1982
Abstract Review Committee, Scientific Sessions of the Royal College of Physicians and Surgeons of Canada	1979

Editorial Board (current): Journal of the American College of Cardiology
Circulation: Guest Editor
European Heart Journal
American Journal of Cardiology
Clinical Cardiology
Coronary Artery Disease
Journal of Cardiopulmonary Rehabilitation and Prevention
Journal of Cardiovascular Pharmacology and Therapeutics
Journal of Electrocardiology
Cardiology Today

Editorial Consultant: New England Journal of Medicine
Journal of the American Medical Association
Annals of Internal Medicine
Archives of Internal Medicine
Canadian Medical Association Journal
Chest
Journal of Arrhythmia (International Advisory Board)
Journal of Catheterization and Cardiovascular Diagnosis

Sabbaticals: Mount Sinai School of Medicine
New York, New York
September 1, 2008 to September 1, 2009
Advanced Cardiac Imaging: Cardiac CT Angiography

Washington University School of Medicine
St. Louis, Missouri
January 1 – June 30, 2001
Noninvasive Imaging: Advanced Echocardiography

Continuing Medical Education:

Cardiovascular Institute's 24th Annual Cardiology Update on "Clinical Management of Heart Disease 2017: Practical Approaches to the Diagnosis and Management of Cardiovascular Disease" Presented "Diabetes and Stable Ischemic Heart Disease" Philadelphia, PA — September 17, 2017

2nd Annual Endpoint Adjudication Conference: Streamline Data Collection Processes to Enable Efficient CEC Review and Regulatory Submissions Panelist: "Adjudicator Perspective - Critical Insights into Process Bottlenecks and Challenges" and "Key Tactics for Ensuring all Involved Parties Agree on Endpoint Approval" Philadelphia, PA — May 4-5, 2016

Harvard Medical School, Cardiovascular Grand Rounds "Myocardial Infarction Defined: A Clinical Trial Perspective" — October 15, 2015

Co-Chair, "Exercise Testing: Rationale of ETT and Comparison with Cardiac Imaging," American College of Cardiology Scientific Session — March 30, 2014

The Kilo Diabetes & Vascular Research Foundation Washington University School of Medicine: "The 39th Annual Symposium Current Topics in Diabetes, Endocrinology and Vascular Disease — November 18-19, 2011

Virginia Commonwealth University School of Medicine: "2011 Update on the Management and Treatment of Stable Ischemic Heart Disease — June 2, 2011

Albert Einstein College of Medicine: "2011 Update on Management and Treatment of Patients with Stable Ischemic Heart Disease" — March 8, 2011

Washington University School of Medicine Cardiology Grand Rounds "Optimal Choice of Initial Medical Therapy, PCI or CABG for Patients with Stable Ischemic Coronary Disease: A 2011 Perspective" — March 2, 2011

Saint Louis University School of Medicine, Internal Medicine Grand Rounds "Troponitis, Application of the ACC/AHA/ESC/WHF/WHO University MI Definition to Ruotine Clinical Care and Need for Downstream Testing" — March 4, 2011

Transcatheter Cardiovascular Therapies (TCT) 2010, Washington, DC — September 21-25, 2010
"BARI-2D Perspectives: Glass Half Empty or Glass Half Full for Revascularization?" & "Impact of Degree of Revascularization and Stent Type on Outcomes in BARI 2D"

The 15th Annual Meeting of the Japanese Association of Cardiac Rehabilitation (JACR), Tokyo, Japan — July 18-19, 2009

18th Cardiology Update Course sponsored by the Foundation for Cardiovascular Research and the European Society of Cardiology Davos, Switzerland — February 15-20, 2009

29th Panhellenic Annual Congress of Hellenic Cardiology Cardiologic Society Conference, Athens, Greece — October 30-November 1, 2008

17th Cardiology Update Course sponsored by the Foundation for Cardiovascular Research and the European Society of Cardiology Davos, Switzerland — February 12-16, 2007

"New Pharmacologic Approaches for the Treatment of Chronic Angina" — June 10, 2005
Department of Medicine, Chiba Hokusoh Hospital, Nippon Medical School Inba Chiba, Japan

The 9th Scientific Meeting for Pharmacotherapy of Cardiovascular Diseases — June 11, 2005
The University of Tokyo, Department of Anesthesiology, Tokyo, Japan

New Management Strategies for Chronic Angina: Harvard, Johns Hopkins Northwestern University — 2004-2005

Co-chair, symposium on Clinical Event Adjudication Committees — January 20-21, 2005
Duke University Medical Center, Duke Clinical Research Institute, Participation by FDA/University Consortium/Pharmaceutical Consortium

Multiple CME programs on Global Risk Factor Reduction and Guidelines to Reduce Atherosclerotic Burden — 2001-2003

Multiple CME programs on Prognostic Risk Stratification in Chronic Angina and its Treatment — 2001-2003

Changing Diagnosis of Acute Myocardial Infarctions – Implications for Practicing Clinical Investigations, "Cardiac Markers – Post CABG" — January 25-27, 2001
Duke University Medical Center, Duke Clinical Research Institute, Vienna Virginia

Cardiology Update for the Primary Caregiver: BR Chaitman, Chair — October 28, 2000
Ritz Carlton Hotel, St. Louis, MO

The Cardiovascular Board Review: For Certification & Recertification. — 2000-2005
"Exercise/Stress Testing," sponsored by American College of Cardiology Hyatt Regency O'Hare, Chicago, IL

Symposium on Chocolate, Antioxidants, Polyphenols and Cardiovascular Health: sponsored by XXII Congress of The European Society of Cardiology, B.R. Chaitman, Moderator; Amsterdam, The Netherlands — August 26-30, 2000

National Institutes of Health/U.S. Food and Drug Administration
"Biomarkers and Surrogate Endpoints: Advancing Clinical Research and Applications,""ECG in Acute Coronary Syndromes" and "The Electrocardiogram as a Biomarker for Myocardial Ischemia in Chronic Ischemic Heart Disease" Bethesda, Maryland — April 15-16, 1999

University of Florida-Gainesville: "Value of ETT in Women with Suspect Ischemic Heart Disease," "Perspective View of Future Directions in Cardiology: Canadian vs. USA," "Diabetes in Cardiovascular Disease" — March 5-6, 1998

St. Luke's Episcopal Hospital/Texas Heart Institute Cardiology Grand Rounds — February 13, 1998

"Diabetes and Heart Disease", Houston, Texas,

University of Virginia Health Sciences Center Cardiology Grand Rounds January 20, 1998
"Cardiovascular Diseases in the Diabetic Patient," Charlottesville, VA

Michigan Heart and Vascular Institute Cardiology Grand Rounds December 9, 1997
"Revascularization Options in Patients with Multi-Vessel Disease PTCA or CABG", Ypsilanti, Michigan

Fifth Annual Meeting of the Missouri Chapter of the American College of Cardiology, "Silent Ischemia in the ACIP Trial", St. Louis, Missouri September 27, 1997

Update in Diabetes and Endocrinology. "Heart Disease in the Diabetic Patient," St. Louis, Missouri September 26, 1997

The Philadelphia Board Review Course October 15-20, 1995, November 2-7, 1997
Course in Cardiovascular Diseases, Philadelphia Heart Institute, The Graduate Hospital, and the American Heart Association; Philadelphia, PA

Current Concepts in Cardiology '97, Presentation: "The Impact of Gender on the Diagnostic & Prognostic Utility of Noninvasive Cardiac Testing for Suspect of Proven Ischemic Heart Disease," Long Island Jewish Medical Center, New Hyde Park, NY May 7, 1997

University of Southern California, Los Angeles, CA Grand Rounds December 20, 1994

New Frontiers in Cardiac Imaging: sponsored by American Society of Nuclear Cardiology; Dallas, Texax November 13, 1994

Symposium on Ischemic Heart Disease Controversies: sponsored by the Spanish Society of Cardiology and European Society of Cardiology Marbella, Spain June 16-17, 1994

How to Become a Clinical Cardiovascular Investigator: sponsored by the Council on Clinical Cardiology of the American Heart Association; American College of Cardiology; National Heart, Lung, and Blood Institute; Bethesda, Maryland. May 6-7, 1994

International Therapeutic Symposium: sponsored by the Japanese Heart Association, Tokyo, Japan November 6, 1993

Clinical Applications of Exercise Testing in Cardiac Disease: American College of Cardiology, Bethesda, Maryland, Program Director 1986-1995

Clinical Exercise Physiology and Cardiac Rehabilitation Conference: American College of Cardiology, Palo Alto, CA, Program Director 1993-1995

Midwest Clinical Molecular Cardiology Conference: B.R. Chaitman and D. Douglas Miller-Moderators, St. Louis, Missouri September 1992-1994

International Conference on Ischemic Syndromes: B.R. Chaitman, D.G. Caralis Program Directors, Athens, Greece June 15-17, 1992

Management Strategies for Hypertensive Patients/Patients with Selective Cardiac Problems, Program, Director, St. Louis, MO August 24, 1991

New Concepts in the Management of Acute Myocardial Infarction: B.R. Chaitman, M. Kern, B.E. Sobel, P. Ludbrook, St. Louis and Washington Universities, St. Louis, Missouri May 25, 1990

Clinical Cardiology: A Practical approach. B.R. Chaitman, A.J. Labovitz Program Directors, St. Louis, Missouri May 19, 1989

The Initial Six Hours after Acute Myocardial Infarction. B.R.Chaitman, P. Ludbrook Directors, St. Louis and Washington Universities, St. Louis, MO May 1987

AHA and ACC Annual Scientific Sessions: Symposia Speaker, Fireside Panel, Meet the Expert Session

Invited lectures not listed

Postdoctoral Fellows:

Akira Kurita, M.D., Associate Professor of Medicine, 1st Department of Internal Medicine
National Defense Medical College, Saitama, Japan
Bonpei Takase, M.D., Assistant Professor of Medicine, Major of Japan Ground Self Defense Force
1st Department of Internal Medicine, National Defense Medical College, Saitama, Japan
Jorge Hernandez, M.D., Private practice, St. Louis, Missouri
Yogesh Shah, M.D., Private practice, New Jersey
Mark D. Wittry, M.D., Assistant Professor of Medicine, Nuclear Medicine Division
St. Louis University School of Medicine
Leonardo R. Maitas, M.D., Attending Cardiologist; Hospital Miguel Perez Carreno
Caracas, Venezuela
Norbert Lingling Uy, M.D., Assistant Professor of Internal Medicine, University of the East,
Ramon Magsaysay Memorial Hospital, Manila, Philippines
Beaver R. Tamesis, M.D., Clinical Instructor, University of the Philippines, Manila,
College of Medicine Philippine General Hospital
Liwa T. Younis, M.D., Ph.D., Private practice, St. Louis, Missouri
Naohiko Osada, M.D., St. Marianna University School of Medicine, Kawasaki, Japan
Yasuhiro Yokoyama, M.D., St. Marianna University School of Medicine, Kawasaki, Japan
Shunta Sakai, M.D., Chiba Hokusoh Hospital, Nippon Medical School, Chiba, Japan
Junko Sano, M.D., Chiba Hokusoh Hospital, Nippon Medical School, Chiba, Japan

Acknowledgments:

American Heart Association Heartland affiliate Arthur E. Strauss Award 2005

Awarded the Food and Drug Administration's Commissioner's Special Citation Award for the development of a format for regulatory submission of annotated electrocardiographic wave form data to meet FDA's needs in assessing the pro-arrhythmic potential of drugs (October 2003)

Listed in the directory *America's Top Doctors*, published by Castle Connolly Medical Ltd., 2001 first edition, 2005-2017

Listed in the directory *The Best Doctors in America* published by Woodward/White, Inc., Aiken, S.D.; edited by Luch Stec, 1992, 1994, 1996, 1999, 2004, 2005-2006, 2009-2017

Life Member; National Registry of Who's Who, copyright 2000; registration number 110341

Keyword Descriptions: Exercise Testing
Coronary Artery Disease
Coronary Bypass Surgery
Valvular Prosthesis

Bibliographical References

1. Alkhawam H, Chaitman B, Salloum M, Abo-Salem E, Ghrair F, Saker E, Shahid S, Lieber J, Helmy T. Myocardial infarct size and sex-related angiographic differences in myocardial infarction in obstructive coronary artery disease. Coronary Artery Disease 2021 In press.

2. Chaitman BR, Alexander KP, Cyr DD, Berger JS, Reynolds HR, Bangalore S, Boden WE, Lopes RD, Demkow M, Perna GP, Riezebos RK, McFalls EO, Banerjee S, Bagai A, Gosselin G, O'Brien SM, Rockhold FW, Waters DD, Thygesen KA, Stone GW, White HD, Maron DJ, Hochman JS; ISCHEMIA Research Group. Myocardial Infarction in the ISCHEMIA Trial: Impact of Different Definitions on Incidence, Prognosis, and Treatment Comparisons. Circulation. 2020 Dec 3. doi: 10.1161/Circulation.120.047987. Epub ahead of print. PMID: 33267610.

3. Farkouh M, Godoy L, Brooks M, Mancini GB, Vlachos H, Bittner V, Chaitman B, Siami S, Hartigan P, Frye R, Boden W, Fuster V. Influence of achieved LDL-cholesterol on cardiovascular outcomes in patients with diabetes mellitus undergoing coronary revascularization. J Am Coll Cardiol 2020;76(19):2197-2207. November 2020.

4. Boden WE, Hartigan PM, Mancini J, Teo KK, Chaitman BR, Maron D, Kostuk W, Hartigan J, Dada M, Spertus J, Bates ER, Weintraub WS on behalf of the COURAGE Trial Investigators. Risk prediction tool for assessing the probability of death or myocardial infarction in patients with stable coronary arter disease. Am J Cardiol 2020;130:1-6. PMID 32654755. DOI:https://doi.org/10.1016/j.amjcard. 2020.05.046. September 2020.

5. Reynolds HR, Shaw LJ, Min JK, Spertus JA, chaitman BR, Berman DS, Picard MH, Kwong RY, Bairey-Merz C, Cyre DD, Lopes RD, Lopez-Sendon J, Held C, Szwed H, Senior R, Gosselin G, Nair RG, Elghamaz A, Bockeria O, Chen J, Chernyavskiy A, Bhargava B, Newman JD, Hinic SB, Jaroch J, Hoye A, Berger J, Boden WE, O'Brien S, Maron DJ, Hochman JS for the ISCHEMIA Research Group. Association of sex with severity of coronary artery disease, ischemia, and symptom burden in patients with moderate or severe ischemia; Secondary analysis of the ISCHEMIA randomized clinical trial. JAMA Cardiol. 2020;5(7):773-86. PMID 32227128. doi: 10.1001/jamacardio.2020.0822.July 2020.

6. Spertus JA, Jones PG, Maron DJ, Mark DB, O'Brien SM, Fleg JL, Reynolds HR, Stone GW, Sidhu MS, Chaitman BR, Chertow GM, Hochman JS, Bangalore S, ISCHEMIA-CKD research group. Health status after invasive or conservative care in coronary and advanced kidney disease. N Engl J Med 2020;382(17):1619-28. PMID 32227754. doi:10.1056/NEJMoa1916374. March 2020.

7. Bangalore S, Maron DJ, O'Brien SM, Fleg JL, Kretov EI, Briguori C, Kaul U, Reynolds HR, Mazurek T, Sidhu MS, Berger JS, Mathew RO, Bockeria O, Broderick S, Pracon R, Herzog CA, Huang Z, Stone GW, Boden WE, Newman JD, Za A, Mark DB, Spergus JA, Alexander KP, Chaitman BR, Chertow GM, Hochman JS, ISCHEMIA-CKD research group. Management of coronary disease in patients with advanced kidney disease. N Engl Lj Md 2020;382(17):1608-18. PMID 32227756. doi:10.1056/NEJMoa1915925. March 2020.

8. Maron DJ, Hochman JS, Reynolds HR, Bangalore S, O'Brien SM, Boden WE, Chaitman BR, Senior R, Lopez-Sendon J, Alexander KP, Lopes RD, Shaw LJ, Berger JS, Newman JD, Sidhu MS, Goodman SG, Ruzyllo W, Gosselin G, Maggioni AP, White HD, Bhargava B, Min JK, Mancini GB, Berman DX, Picard MH, Kwong RY, Ali ZA, Mark DB, Spertus JA, Krishnan MN, Elghamaz A, Moorthy N, Hueb

WA, Demkow M, Mavromatis K, Bockeria O, Peterio J, Miller TD, Szwed H, Doerr R, Keltai M, Selvanayagam JB, Steg PG, Held C, Kohsaka S, Mavromichalis S, Kirby R, Jeffries NO, Harrell FE, Rockhold FW, Broderick S, Ferguson TB, Williams DO, Harrington RA, Stone GW, Rosenberg Y, ISCHEMIA Research Group. Initial invasive or conservative strategy for stable coronary disease. N Engl J Med 2020;382(15):1395-1407. PMID 32227755. Doi:10.1056/NEJMoa1915922. March 2020.

9. Genuth SM, Vlachos H, Brooks MM, Bantle J, Chaitman BR, Green J, Kelsey SF, King SB III, McBane R, Sako EY, Schneider DJ, Steffes M, Frye RL on behalf of the BARI 2D Study Group. BARI 2D: A reanalysis focusing on cardiovascular events. Mayo Clin Proc 2019;94(11):2249-2262. November 2019. Doi.org/10.1016/j.mayocp.2019.04.015.

10. Schwartz GG, Chaitman BR. Initiating PCSK9 inhibition in hospital for ACS. We can, but does that mean we should? J Am Coll Cardiol 2019;74(20):2463-2465. November 2019 doi.org/10.1016/j.jacc.2019.09.039.

11. Hochman JS, Reynolds HR, Bangalore S, O'Brien SM, Alexander KP, Senior R, Boden WE, Stone GW, Goodman SG, Lopes RD, Lopez-Sendon J, White HD, Maggioni AP, Shaw LJ, Min JK, Picard MH, Berman DS, Chaitman BR, Mark DB, Spertus JA, Cyr DD, Bhargava B, Ruzyllo W, Wander GS, Chernyavskiy AM, Rosenberg YD, Maron DJ for the ISCHEMIA Research Group. Baseline characteristics and risk profiles of participants in the ISCHEMIA Randomized Clinical Trial. JAMA Cardiol. 2019;4(3):273-286. doi: 10.1001/jamacardio.2019.0014.

12. Farkouh ME, Sidhu MS, Brooks MM, Vlachos H, Boden WE, Frye RL, Hartigan P, Siami FS, Bittner VA, Chaitman BR, Mancini GB, Fuster V. Impact of chronic kidney disease on outcomes of myocardial revascularization in patients with diabetes. J Am Coll Cardiol 2019;73(4):400-11. DOI: 10.1016/j.jacc.2018.11.044

13. Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, White HD, Mickley H, Crea F, Van de Werf F, Bucciarelli-Ducci C, Katus HA, Pinto FJ,. Antman EM, Hamm CW, De Caterina R, Januzzi Jr, JL, Apple FS, Alonso MA, Underwood SR, Canty Jr, JM, Lyon AR, Devereauz PF, Zamorano JL, Lindahl B, Weintraub WS, Newby LK, Virmani R, Vranckx P, Cutlip D, Gibbons RJ, Smith SC, Atar D, Luepker RV, Robertson RM, Bonow RO, Steg PG, O'Gara PT, Fox KA: The Executive Group on behalf of the Joint European Society of Cardiology (ESC)/American College of Cardiology (ACC)/American Heart Association (AHA)/World Heart Federation (WHF) Task Force for the University Definition of Myocardial Infarction. Fourth universal definition of myocardial infarction (2018). *Eur Hear J* 2018;00:1-33/ *JACC* 2018;72:2231-2264/*Circulation*. 2018;138:e618–e651. DOI: 10.1161/CIR.0000000000000617 PMID:30571511/*Kardiol Pol* 2018;76(10):1383-1415 PMID:30338834/*Glob Heart* 2018;13(4):305-338 PMID:30154043.

14. Pallisgaard JL, Brooks MM, Chaitman B, Boothroyd DB, Perez M, Hlatky MA. On behalf of the BARI 2D Study Group. Thiazolidinediones and risk of atrial fibrillation among patients with diabetes and coronary disease. *Am J Med* 2018;131(7):805-12. PMID: 29581079.

15. Weintraub WS, Hartigan PM, Mancini GM, Teo KK, Maron DJ, Spertus JA, Chaitman BR, Shaw LJ, Berman D, Boden WE on behalf of the COURAGE Trial Investigators. Effect of coronary anatomy and myocardial ischemia on long-term survival in patients with stable ischemic heart disease. *Circulation: Cardiovascular Quality and Outcomes* 2019. Accepted for publication.

16. Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, White HD. Clarifying the proper definitions for type 2 myocardial infarction. *J Am Coll Cardiol* 2018;71:1291.

17. Chaitman BR, Brooks MM, Fox K, Luscher TF. ORBITA revisited: what it really means and what it does not? *Eur Heart J* 2018;39:963-965. PMID: 29324991

18. Abo-Salem E, Chaitman B, Helmy T, Boakye EA, Lim M. Patent foramen ovale closure versus medical therapy in cases with cryptogenic stroke, meta-analysis of randomized controlled trial. *J Neurol* 2018;265(3):578-85. PMID: 29356972.

19. Chaitman BR. Exaggerated exercise-induced systolic blood pressure response. Arterial baroreceptor sensivitiy or carotid stiffness? *Eur Heart J* 2018;39:607-609. PMID: 29281067.

20. Hicks KA, Mahaffey KW, Mehran R, Nissen SE, Wiviott SD, Dunn B, Solomon SD, Marler JR, Teerlink JR, Farb A, Morrow DA, Targum SL, Sila CA, Thanh Hai MT, Jaff MR, Joffe HV, Cutlip DE, Desai AS, Lewis EF, Gibson CM, Landray MJ, Lincoff AM, White CJ, Brooks SS, Rosenfield K, Domanski MJ, Lansky AJ, McMurray JJV, Tcheng JE, Steinhubl SR, Burton P, Mauri L, O'Connor CM, Pfeffer MA, Hung HMJ, Stockbridge NL, Chaitman BR, Temple RJ, on behalf of the Standardized Data Collection for Cardiovascular Trials Initiative (SCTI).2017 Cardiovascular and stroke endpoint definitions for clinical trials. *J Am Coll Cardiol* 2018;71:1021-1034. PMID: 29495982 *Circulation* 2018;137:961-972. PMID: 29483172

21. Mancini GBJ, Boden WE, Brooks MM, Vlachos H, Chaitman BR, Frye R, Bittner VA, Hartigan PM, Dagenais GR. Impact of treatment strategies on outcomes in patients with stable coronary artery disease and type 2 diabetes mellitus according to presenting angina severity: A pooled analysis of three Federally-funded randomized trials. *Atherosclerosis* (2018), https://doi.org/10.1016/j.atherosclerosis.2018.04.005. PMID: 29861270

22. Genuth SM, Vlachos HM, Brooks MM, Bantle JP, Chaitman BR, Green J, Kelsey SF, King SB, McBane R, Sako EY, Schneider DJ, Steffes M, Frye RL. The effects of insulin sensitizing versus insulin providing glycemic therapy and coronary revascularization versus intensive coronary risk factor reduction on cardiovascular disease events in Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI 2D) Trial. *Mayo Clin Proc* 2019 (Accepted for publication).

23. Bagai A, Alexander KP, Berger JS, Senior R, Sajeev C, Pracon R, Mavromatis K, Lopez-Sendón JL, Gosselin G, Diaz A, Perna G, Drozdz J, Humen D, Petrauskiene B, Cheema AN, Phaneuf D, Banerjee S, Miller TD, Kedev S, Schuchlenz H, Stone GW, Goodman SG, Mahaffey KW, Jaffe AS, Rosenberg YD, Bangalore S, Newby LK, Maron DJ, Hochman JS, Chaitman BR. Use of troponin assay 99th percentile as the decision level for myocardial infarction diagnosis. *Am Heart J* 2017;190:135-139. PMID:28760208

24. Kloner, Chaitman BR. Angina and its Management. J Cardiovasc Pharmacol Ther 2017;22:199-209. PMID: 28196437

25. Everett BM, Brooks MM, Vlachos HEA, Chaitman BR, Frye RL, Bhatt DL. Sex differences in cardiac troponin and the risk of death of major cardiovascular events. *J Am Coll Cardiol* 2016;68(9):978-980. PMID: 27561773

26. Wolk R, Bertolet M, Singh P, Brooks MM, Pratley R, Frye RL, Mooradian AD, Rutter MK, Calvin AD, Chaitman BR, Somers VK; for the BARI 2D Study Group. Prognostic value of adipokines in predicting cardiovascular outcome – explaining the obesity paradox. *Mayo Clin Proc* 2016;91:858-866. PMID: 27289411.

27. Shaw L, Xie J, Phillips L, Reynolds H, Berman D, Devlin G, chaitman BR. Optimizing diagnostic accuracy with the exercise electrocardiogram: Opportunities for women and men with stable ischemic heart disease. *Heart Asia* 2016;8:1-7. PMID: 27326241

28. Mancini GBJ, Farkouh ME, Brooks MM, Chaitman BR, Boden WE, Vlachos H, Hartigan

PM, Siami FS, Sidhu MS, Bittner V, Frye R, Fuster V. Medical treatment and revascularization options in type 2 diabetes and coronary disease. *J Am Coll Cardiol* 2016;68:985-995. PMID: 27585501

29. Chaitman B. Race and Sex Differences in the Incidence and Prognostic Significance of Silent Myocardial Infarction in the Atherosclerosis Risk in Communities (ARIC) Study. PracticeUpdate website. http://www.practiceupdate.com/content/race-and-gender-differences-in-silent-myocardial-infarction/39531/65/2/1. Accessed June 07, 2016

30. Acharjee S, Teo KK, Jacobs AK, Hartigan PM, Barn K, Gosselin G, Tanguay JF, Maron DJ, Kostuk WJ, Chaitman BR, Mancini GBJ, Spertus JA, Dada MR, Bates ER, Booth DC, Weintraub WS, O'Rourke RA, Boden WE, on behalf of the COURAGE Trial Research Group. Optimal medical therapy with or without percutaneous coronary intervention in women with stable coronary disease: A pre-specified subset analysis of the COURAGE (Clinical Outcomes Utilizing Revascularization and Aggressive drug Evaluation) Trial. *Am Heart J* 2016;173:117-108. PMID: 26920603

31. Sedlis SP, Hartigan PM, Teo KK, Maron DJ, Spertus JA, Mancini J, Kostuk W, Chaitman BR, Berman D, Lorin JD, Dada M, Weintraub WS, Boden WE, on behalf of the COURAGE Trial Investigators. Effect of PCI on long-term survival in patients with stable ischemic heart disease.*N Engl J Med* 2015;373:1937-1946. PMID: 26559572

32. Padala S, Sidhu MS, Hartigan PM, Maron DJ, Teo KK, Spertus JA, Mancini GB, Sedlis SP, Chaitman BR, Heller GV, Weintraub WS, Boden WE. Effect of baseline exercise capacity on outcomes in patients with stable coronary heart disease (a post hoc analysis of the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) Trial. Am J Cardiol. 2015; 116:1509-1515. PMID: 26410604.

33. Chaitman BR. Is the 99th percentile the optimal reference limit to diagnose myocardial infarction with high-sensitivity cardiac troponin assays in patients with chronic kidney disease? *Circulation* 2015; 131:2029-2031. PMID: 25948540.

34. Everett BM, Brooks MM, Vlachos HEA, Chaitman BR, Frye RL, Bhatt DL, for the BARI 2D Study Group. Troponin and cardiac events in stable ischemic heart disease and diabetes. *N Engl J Med* 2015;373:610-620. PMID: 26267622

35. Arnold SV, McGuire DK, Spertus JA, Tang F, Yue P, Inzucchi SE, Belardinelli L, Chaitman BR, Kosiborod M. Glucose-lowering medications and angina burden in patients with stable coronary disease: Results from the Type 2 Diabetes Evaluation of Ranolazine in Subjects with Chronic Stable Anging (TERISA) trial. *Am Heart J* 2015;170:753-759.e2. PMID: 26386799

36. Hicks KA, Tcheng JE, Bozkurt B, Chaitman BR, Cutlip DE, Farb A, Fonarow GC, Jacobs JP, Jaff MR, Lichtman JH, Limacher MC, Mahaffey KW, Mehran R, Nissen SE, Smith EE, Targum SL; ACC/AHA Task Force on Clinical Data Standards Members. 2014 ACC/AHA Key Data Elements and Definitions for Cardiovascular Endpoint Events in Clinical Trials: A Report of the ACC/AHA Association Task Force on Clinical Data Standards (Writing Committee to Develop Cardiovascular Endpoints Data Standards). *J Nucl Cardiol* 2015;5:1041-144. PMID: 26204990.

37. Carson JL, Sieber F, Cook DR, Hoover DR, Noveck H, Chaitman BR, Fleisher L, Beaupre L, Macaulay W, Rhoads GG, Paris B, Zagorin A, Sanders DW, Zakriya KJ, Magaziner J. Liberal versus restrictive blood transfusion strategy: 3-year survival and cause of death results from the FOCUS randomized controlled trial. *Lancet* 2015;385:1183-1189. PMID: 25499165.

38. Hicks KA, Tcheng JE, Bozkurt B, Chaitman BR, Cutlip DE, Farb A, Fonarow GC, Jacobs JP, Jaff MR, Lichtman JH, Limacher MC, Mahaffey

KW, Mehran R, Nissen SE, Smith EE, Targum SL. 2014 ACC/AHA Key data elements and definitions for cardiovascular endpoint events in clinical trials. *J Am Coll Cardiol* 2015;66:403-469. PMID:25553722. *Circulation* 2015; 132:302-361. PMID 25547519.

39. Scirica BM, Belardinelli L, Chaitman B, Waks JW, Volo S, Karwatowska-Prokopczuk E, Murphy SA, Cheng M, Braunwald E, Morrow DA. Effect of ranolazine on atrial fibrillation in patients with non-ST elevation acute coronary syndromes – observations from the MERLIN-TIMI 36. *Europace* 2015; 17:32-37. PMID: 25210025.

40. Kosiborod M, Arnold SV, Spertus JA, McGuire DK, Yue P, Ben-Yehuda O, Belardinelli L, Chaitman BR. Letter, TERISA Trial. *J Am Coll Cardiol* 2014;64:420-421. PMID: 25060381.

41. Maron BJ, Friedman RA, Kligfield P, Levine BD, Viskin S, Chaitman BR, Okin PM, Saul JP, Salberg L, Van Hare GF, Soliman EZ, Chen J, Matherne GP, Bolling SF, Mitten MJ, Caplan A, Balady GJ, Thompson PD. Assessment of the 12-lead electrocardiogram as a screening test for detection of cardiovascular disease in healthy general populations of young people (12-25 years of age): A Scientific Statement of the American Heart Association and the American College of Cardiology. *Circulation* 2014;130:1303-1334, PMID: 25223981. *J Am Coll Cardiol* 2014;64:1479-1514. PMID: 25234655.

42. Arnold SV, McGuire DK, Spertus JA, Li Y, Yue P, Ben-Yehuda O, Belardinelli L, Jones PG, Olmsted A, Chaitman BR, Kosiborod M. Effectiveness of ranolazine in patients with type 2 diabetes mellitus and chronic stable angina according to baseline hemoglobin A_{1c}. *Am Heart J* 2014; 168:457-465.e2. PMID: 25262254.

43. Maleki ND, Stocke K, Zheng Y, Westerhout CM, Fu Y, Chaitman BR, Awad A, Jagasia P, Armstrong PW. An assessment of ST-segment measurement variability between two core electrocardiographic laboratories. J Electrocardiol 2014;p 47(1):38-44. PMID: 24246251.

44. Bao MH, Zheng Y, Westerhout CM, Fu Y, Wagner GS, Chaitman BR, Granger CB, Armstrong PW. Prognostic implications of quantitative evaluation of baseline Q-wave width in ST-segment elevation myocardial infarction. *J Electrocardiol* 2014; 47:465-471. PMID: 24853083.

45. Mancini GBJ, Hartigan PM, Shaw LJ, Berman DS, Hayes Sw, Bates ER, Maron DJ, Teo K, Sedlis SP, Chaitman BR, Weintraub WS, Spertus JA, Kostuk WJ, Dada M, Booth DC, Boden WE. Predicting outcome in the COURAGE (Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation) Trial. Coronary anatomy versus ischemia. *J Am Coll Cardiol Intv*. 2014; 7(2):195-201. PMID 24440015

46. Dianati MN, Stocke K, Zheng Y, Westerhout CM, Fu Y, Chaitman BR, Awad A, Jagasia P, Armstrong PW. An assessment of ST-segment measurement variability between two core electrocardiogram laboratories. *J Electrocardiol* 2014; 47(1):38-44. PMID: 24246251

47. Acharjee S, Boden WE, Hartigan PM, Teo KK, Maron DJ, Sedlis SP, Kostuk W, Spertus JA, Dada M, Chaitman BR, Mancini GBJ, Weintraub WS. Low levels of high-density lipoprotein cholesterol and increased risk of cardiovascular events in stable ischemic heart disease patients. A post-hoc analysis from the COURAGE Trial (Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation). *J Am Coll Cardiol* 2013;62:1826-1833. PMID 23973693

48. Mandyam MC, Soliman EZ, Alonso A, Dewland TA, Heckbert SR, Vittinghoff E, Cummings SR, Ellinor PT, Chaitman BR, Stocke K, Applegate WB, Arking DE, Butler J, Loehr LR, Magnani JW, Murphy RA, Satterfield S, Newman AB, Marcus GM. The QT interval and risk of incident atrial fibrillation. *Heart Rhythm* 2013;10(10):1562-1568. PMID:23872693

49. Mancini GBJ, Hartigan PM, Bates ER, Chaitman BR, Sedlis SP, Maron DJ, Kostuk WJ, Spertus JA, Teo KK, Dada M, Knudtson M, Berman DS, Booth DC, Boden WE, Weintraub WS. Prognostic importance of coronary anatomy and left ventricular ejection despite optimal therapy: Assessment of residual risk in the Clinical Outcomes Utilizing Revascularization and Aggressive DruG Evaluation Trial. *Am Heart J* 2013;166:481-487. PMID 24016497

50. Teo KK, Goldstein LB, Chaitman BR, Grant S, Weintraub WS, Anderson DC, Sila CA, Cruz-Flores S, Padley RJ, Kostuk WJ, Boden WE, on behalf of the AIM-HIGH Investigators. Extended-release niacin therapy and risk of ischemic stroke in patients with cardiovascular disease. The Atherothrombosis Intervention in Metabolic Syndrome With Low HDL/High Triglycerides: Impact on Global Health Outcome (AIM-HIGH) Trial. *Stroke* 2013;44:2688-2693. PMID 23881958

51. Carson JL, Brooks MM, Abbott JD, Chaitman BR, Kelsey SF, Triulzi DJ, Srinivas V, Menegus MA, Marraquin OC, Rao SV, Noveck H, Passano E, Hardison RM, Smitherman T, Vagaonescu T, Wimmer NJ, Williams DO. Liberal versus restrictive transfusion thresholds for patients with symptomatic coronary artery disease. *Am Heart J*, 2013;165;964-971.e1.

52. Kosiborod M, Arnold SV, Spertus JA, McGuire DK, Li Y, Yue P, Ben-Yehuda O, Katz A, Jones PG, Olmsted A, Belardinelli L, Chaitman BR. Evaluation of ranolazine in patients with type 2 diabetes mellitus and chronic stable angina. Results from the TERISA randomized clinical trial. *J Am Coll Cardiol* 2013;61:2038-2045. PMID: 23500237.

53. Cannon CP, Brindis RG, Chaitman BR, Cohen DJ, Cross JT Jr, Drozda JP Jr, Fesmire FM, Fintel DJ, Fonarow GC, Fox KA, Gray DT, Harrington RA, Hicks KA, Hollander JE, Krumholz H, Labarthe DR, Long JB, Mascette AM, Meyer C, Peterson ED, Radford MJ, Roe MT, Richmann JB, Selker HP, Shahian DM, Shaw RE, Sprenger S, Swor R, Underberg JA, Van de Werf F, Weiner BH, Weintraub WS. 2013 ACCF/AHA key data elements and definitions for measuring the clinical management and outcomes of patients with acute coronary syndromes and coronary artery disease: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Clinical Data Standards (Writing Committee to Develop Acute Coronary Syndromes and Coronary Artery Disease Clinical Data Standards). *J Am Coll* Cardiol 2013;61:992-1025, PMID: 23369353; *Circulation* 2013;127:1052-1089, PMID: 23357718; *Critical Pathways in Cardiology* 2013;12:65-105. PMID: 23357718.

54. Elizaga ML, Vasan S, Marovich MA, Sato AH, Lawrence DN, Chaitman BR, Frey SE, Keefer MC, for the MVA Cardiac Safety Working Group. Prospective surveillance for cardiac adverse events in healthy adults receiving modified vaccinia Ankara vaccines: A systematic review. *PLoS ONE* 2013;8(1): e54407. doi:10.1371/journal.pone.0054407. PMID: 23349878.

55. Shaw LJ, Cerqueira MD, Brooks MM, Althouse AD, Sansing VV, Beller GA, Pop-Busui R, Taillefer R, Chaitman BR, Gibbons RJ, Jeo J, Iskandrian AE. Impact of left ventricular function and the extent of ischemia and scar by stress myocardial perfusion imaging on prognosis and therapeutic risk reduction in diabetic patients with coronary artery disease: Results from the Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI 2D) trial. *J Nucl Cardiol* 2012;19:658-69. PMID: 22527794.

56. Schwartz GG, Olsson AG, Abt M, Ballantyne CM, Barter PJ, Brumm J, Chaitman BR, Holme IM, Kallend D, Leiter LA, Leitersdorf E, McMurray JJV, Hundl H, Nicholls SJ, Shah PK, Tardif JC, Wright RS, for the dal-OUTCOMES Investigators. Effects of dalcetrapib in patients with a recent acute coronary syndrome. *N Engl J Med* 2012;22:2089-2099. PMID: 23126252.

57. Brooks MM, Chaitman BR, Nesto RW, Hardison RM, Feit F, Gersh BJ, Krone RJ, Sako EY, Rogers WJ, Garber AJ, King SB, Davidson CJ, Ikeno F, Frye RL, for the BARI 2D Study Group. Clinical and angiographic risk stratification and differential impact on treatment outcomes in the Bypass Angioplasty Revascularization Investigation (BARI 2D) Trial. *Circulation* 2012;126:2115-2124. PMID: 23008442.

58. Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD: the Writing Group on behalf of the Joint ESC/ACCF/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction. Third universal definition of myocardial infarction. *Eur Heart J* 2012;33:2551-2567; *Circulation* 2012;126:2020-2035; *J Am Coll Cardiol* 2012;60:1581-1598; World Heart Federation *Nat Rev Cardiol* 2012;9:620-633. PMID: 22958960

59. Shaw LJ, Weintraub WS, Maron DJ, Hartigan PM, Hachamovitch R, Min JK, Dada M, Mancini GBJ, Hayes SW, O'Rourke RA, Spertus JA, Kostuk W, Gosselin G, Chaitman BR, Knudtson M, Friedman J, Slomka P, Germano G, Bates ER, Teo KK, Boden WE, Berman DS. Baseline stress myocardial perfusion imaging results and outcomes in patients with stable ischemic heart disease randomized to optimal medical therapy with or without percutaneous coronary intervention. *Am Heart J* 2012;164:243-250. PMID: 22877811.

60. Gosselin G, Teo KK, Tanguay JF, Gokhale R, Hartigan PM, Maron DJ, Gupta V, Mancini GBJ, Bates ER, Chaitman BR, Spertus JA, Kostuk WJ, Dada M, Sedlis SP, Berman D, Shaw LJ, O'Rourke RA, Weintraub WS, Boden WE, on behalf of the COURAGE Trial Investigators. Effectiveness of percutaneous coronary intervention in patients with silent myocardial ischemia (post hoc analysis of the COURAGE Trial). *Am J Cardiol* 2012;109:954-959. PMID: 22445578.

61. Chaitman BR, Ho AP, Behm MO, Rowe JF, Palcza JS, Laethem T, Heirman I, Panebianco DL, Kobalava Z, Martsevich SY, Free AL, Bittar N, Chrysant SG, How TW, Chodakewitz JA, Murphy MG, Blanchard RL. A randomized, placebo-controlled study of the effects of telcagepant on exercise time in patients with stable angina. *Clinical Pharmacology & Therapeutics* 2012;91:459-466.

62. Ho TW, Ho AP, Chaitman BR, Johnson C, Mathew NT, Kost J, Fan X, Aurora SK, Brandes JL, Fei K, Beebe L, Lines C, Krucoff MW. Randomized, controlled study of telcagepant in patients with migraine and coronary artery disease. *Headache* 2012;52:224-235. PMID: 22221076.

63. Carson JL, Terrin ML, Noveck H, Sanders DW, Chaitman BR, Rhoads GG, Nemo G, Dragert K, Beaupre L, Hildebrand K, Maccaulay W, Lewis C, Cook DR, Dobbin G, Zakriya K, Apple FS, Horney RA, Magaziner J, for the FOCUS Investigators. Liberal or restrictive transfusion in risk patients after hip surgery. *N Engl J Med* 2011;365:2453-2462. PubMed#: 22168590; PMCID: PMC3268062.

64. Boden WE, Probstfield JL, Anderson T, Chaitman BR, Desvignes-Nickens P, Koprowicz K, McBride R, Teo K, Weintraub W. Niacin in patients with low LDL cholesterol levels receiving intensive statin therapy. *New Engl J Med* 2011;365-2255-67. PMID: 22085343.

65. Chaitman BR, Laddu A. Stable angina pectoris: antianginal therapies and future directions. *Nature Reviews Cardiol* 2012;9:40-52. PMID: 21878880.

66. Chaitman BR, Reis L. Should exercise myocardial perfusion imaging be the standard noninvasive approach for the initial evaluation of symptomatic women with suspected coronary artery disease? *Circulation* 2011;124:1207-1209. PMID: 21911793.

67. Mancini GBJ, Hartigan PM, Bates ER, Sedlis SP, Maron DJ, Spertus JA, Berman DS, Kostuk WJ, Shaw LJ, Weintraub WS, Teo KK, Dada M, Chaitman BR, O'Rourke RA, Boden WE, on behalf of the COURAGE Investigators and Coordinators. Angiographic disease progression and residual risk of cardiovascular events while on optimal medical therapy: Observations from the COURAGE trial. *Circulation: Cardiovascular Interventions* 2011;4: 545-552. PMID: 22045968.

68. Schwartz GG, Chaitman BR, Goldberger JJ, Messig M. High-dose atorvastatin and risk of atrial fibrillation in patients with prior stroke or transient ischemic attack: Analysis of the Stroke Prevention by Aggressive Reduction in Cholesterol Levels (SPARCL) trial. *Am Heart J* 2011;161:993-999. PMID: 21570534.

69. Maron DJ, Boden WE, Spertus JA, Hartigan PM, Mancini GBJ, Sedlis SP, Kostuk WJ, Chaitman BR, Shaw LJ, Berman DS, Dada M, Teo KK, Weintraub WS, O'Rourke RA, for the COURAGE Trial Research Group. Impact of metabolic syndrome and diabetes on prognosis and outcomes with early percutaneous coronary intervention in the COURAGE (Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation) Trial. *J Am Coll Cardiol* 2011;58:131-137. PMID: 21718908.

70. Domanski MJ, Mahaffey K, Hasselblad V, Brener SJ, Smith PK, Hillis G, Engoren M, Alexander JH, Levy JH, Chaitman BR, Broderick S, Mack MJ, Pieper KS, Farkouh ME. Association of myocardial enzyme elevation and survival following coronary artery bypass graft surgery. *JAMA* 2011;305:585-591. PMID: 21304084.

71. The AIM-HIGH Investigators. The role of niacin in raising high-density lipoprotein cholesterol to reduce cardiovascular events in patients with atherosclerotic cardiovascular disease and optimally treated low-density lipoprotein cholesterol: Rationale and study design. The Atherothrombosis Intervention in Metabolic syndrome with low HDL/high triglycerides: Impact on Global Health outcomes (AIM-HIGH) trial. *Am Heart J* 2011;161:471-477.e2. PMID: 21392600; PMC3120226.

72. The AIM-HIGH Investigators. The role of niacin in raising high-density lipoprotein cholesterol to reduce cardiovascular events in patients with atherosclerotic cardiovascular disease and optimally treated low-density lipoprotein cholesterol: baseline characteristics of study participants. The Atherothrombosis Intervention in Metabolic syndrome with low HDL/high triglycerides: Impact on Global Health outcomes (AIM-HIGH) trial. *Am Heart J* 2011;161:538-543.

73. Stone P, Chaitman BR, Stocke K, Sano J, DeVault A, Koch GG. The Anti-Ischemic Mechanism of Action of Ranolazine in Stable Ischemic Heart Disease. *J Am Coll Cardiol* 2010;56:934-942. PMID: 20828645.

74. Chaitman BR, Hadid M, Laddu AA. Choice of initial medical therapy vs. prompt coronary revascularization in patients with type 2 diabetes and stable ischemic coronary disease with special emphasis on the BARI 2D trial results. *Curr Opin Cardiol* 25:597-602, 2010. PubMed #: 20885315.

75. Chaitman BR, Hartigan PM, Booth DC, Teo KK, Mancini GB, Kostuk WJ, Spertus JA, Maron DJ, Dada M, O'Rourke RA, Weintraub WS, Berman DS, Shaw LJ, Boden WE, on behalf of the COURAGE trial investigators. Do major cardiovascular outcomes in patients with stable ischemic heart disease in COURAGE differ by healthcare system? *Circ: Cardiovasc Qual Outcomes* 2010;3:476-483. PMID: 20664026.

76. Maron DJ, Boden WE, O'Rourke RA, Hartigan PM, Calfas KJ, Mancini GBJ, Spertus JA, Dada M, Kostuk WJ, Knudtson M, Harris CL, Sedlis SP, Zoble RG, Title LM, Gosselin G, Nawaz S, Gau GT, Blaustein AS, Bates ER, Shaw LJ, Berman DS, Chaitman BR, Weintraub WS, Teo KK, for the COURAGE Trial Research Group.

Intensive multifactorial intervention for stable coronary artery disease: optimal medical therapy in the COURAGE (Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation) Trial. *J Am Coll Cardiol* 2010;55:1348-1358. Pubmed #20338496

77. Schwartz GG, Olsson AG, Ballantyne CM, Barter PJ, Holme IM, Kallend D, Leiter LA, Leitersdorf E, McMurrah JJV, Shah PK, Tardif JC, Chaitman BR, Duttlinger-Maddux R, Mathieson J, on behalf of the dal-OUTCOMES Committees and Investigators. Rationale and design of the dal-OUTCOMES trial: Efficacy and safety of dalcetrapib in patients with recent acute coronary syndrome. *Am Heart J* 2009;158:896-901.e3. PMID: 19958854.

78. Chaitman BR, Hardison RM, Adler D, Gebhart S, Grogan M, Ocampo S, Sopko G, Ramires JA, Schneider D, Frye RL, and the Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI 2D) Study Group. The Bypass Angioplasty Revascularization Investigation 2 Diabetes randomized trial of different treatment strategies in type 2 diabetes mellitus with stable ischemic heart disease. Impact of treatment strategy on cardiac mortality and myocardial infarction. *Circulation* 2009;120:2529-2540. PubMed #19920001. PMC2830563; NIHMS166880.

79. Maron DJ, Spertus JA, Mancini J, Hartigan PM, Sedlis SP, Bates ER, Kostuk WJ, Dada M, Berman DS, Shaw LJ, Chaitman BR, Teo KK, O'Rourke RA, Weintraub WS, Boden WE, for the COURAGE Trial Research Group. Impact of an initial strategy of medical therapy without percutaneous coronary intervention in high-risk patients from the Clinical Outcomes Utilizing Revascularization and Aggressive DruG Evaluation (COURAGE) Trial. *Am J Cardiol* 2009;104:1055-1062.

80. Teo KK, Sedlis SP, Boden WE, O'Rourke RA, Maron DJ, Hartigan PM, Dada M, Gupta V, Spertus JA, Kostuk WJ, Berman DS, Shaw LJ, Chaitman BR, Mancini GBJ, Weintraub WS, on behalf of the COURAGE Trial Investiators. Optimal medical therapy with or without percutaneous coronary intervention in older patients with stable coronary disease. *J Am Coll Cardiol* 2009;54:1303-1308.

81. Brooks MM, Chaitman BR, Molitch ME, for the BARI 2D Study Group. Therapies for type 2 diabetes and coronary artery disease. *N Engl J Med* 2009;361:1409.

82. Boden WE, O'Rourke RA, Teo KK, Maron DJ, Hartigan PM, Sedlis SP, Dada M, Labedi M, Spertus JA, Kostuk WJ, Berman DS, Shaw LJ, Chaitman BR, Mancini GBJ, Weintraub WS, on behalf of the COURAGE trial investigators. Impact of optimal medical therapy with or without percutaneous coronary intervention on long-term cardiovascular end points in patients with stable coronary artery disease (from the COURAGE Trial). *Am J Cardiol* 2009;104:1-4.

83. Mancini GBJ, Bates ER, Maron DJ, Hartigan P, Dada M, Gosselin G, Kostuk W, Sedlis SP, Shaw LJ, Berman DS, Berger PB, Spertus J, Mavromatis K, Knudtson M, Chaitman BR, O'Rourke RA, Weintraub WS, Teo K, Boden WE, on behalf of the COURAGE Trial Investigators and Coordinators. Quantitative Results of Baseline Angiography and Percutaneous Coronary Intervention in the COURAGE Trial. *Circ Cardiovasc Qual Outcomes* 2009; 2:320-327.

84. Frye RL, August P, Brooks M, Hardison RM, Kelsey SF, MacGregor JM, Orchard TJ, Chaitman BR, Genuth SM, Goldberg SH, Hlatky MA, Jones TLZ, Molitch ME, Nesto RW, Sako EY, Sobel BE, the BARI IID Study Group. A randomized trial of therapies for type 2 diabetes and coronary artery disease. *N Engl J Med* 2009; 360:2503-2515. PubMed #: 19502645; PMCID 2863990.

85. Wilson SR, Scirica BM, Braunwald E, Murphy SA, Karwatowska-Prokopczuk E, Buros JL, Chaitman BR, Morrow DA. Efficacy of ranolazine in patients with chronic angina observations from the randomized, double-blind, placebo-controlled MERLIN-TIMI

(Metabolic Efficiency With Ranolazine for Less Ischemia in Non-ST-Segment Elevation Acute Coronary Syndromes) 36 Trial. *J Am Coll Cardiol* 2009;53:1510-6.

86. Morrow DA, Scirica BM, Chaitman BR, McGuire DK, Murphy SA, Karwatowska-Prokopczuk E, McCabe CH, Braunwald E; MERLIN-TIMI 36 Investigators. Evaluation of the glycometabolic effects of ranolazine in patients with and without diabetes mellitus in the MERLIN-TIMI 36 randomized controlled trial. *Circulation* 2009;119:2032-9.

87. Brooks MM, Barsness G, Chaitman BR, Chung SC, Faxon D, Feit F, Frye R, Genuth S, Green J, Hlatky M, Kelsey S, Kennedy F, Krone R, Nesto R, Orchard T, O'Rourke R, Rihal C, Tardif JC. Baseline characteristics of patients with diabetes and coronary artery disease enrolled in the BARI 2D Trial. *Am Heart J* 156(3);528-536.e5, 2008.
PubMed #: 18760137; PMCID 2701266.

88. Shaw LJ, Veledar E, Berman DS, Hayes SW, Friedman J, Slomka P, Germano G, Maron DJ, Mancini GBJ, Hartigan PM, Weintraub WS, O'Rourke RA, Heller GV, Dada M, Spertus JA, McCallister B, Chaitman BR, Gosselin G, Berger P, Kostuk WJ, Schwartz RG, Knudtson M, Bates ER, Teo KK, Boden WE and for the COURAGE Investigators. Response to letters regarding article, "Optimal medical therapy with or without percutaneous coronary intervention to reduce ischemic burden: results from the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) Trial Nuclear Study. *Circulation* 2008;118:e840-841.

89. Sano J, Chaitman BR, Swindle J, Frey SE. Electrocardiography Screening for Cardiotoxicity after Modified Vaccinia Ankara Vaccination. *Am J Med* 122:79-84, 2009. PubMed# 19114175.

90. Chaitman BR, Fromer M. Should ECG be required in young athletes? *Lancet* 371:1489-1490, 2008.

91. Mentzer RM, Jr., Bartels C, Bolli R, Boyce S, Buckberg G, Chaitman B, Haverich A, Knight J, Menasché P, Myers ML, Nicolau J, Simoons M, Thulin L, Weisel R. Sodium Hydrogen Exchange Inhibition by Cariporide to reduce the risk of ischemic cardiac events in patients undergoing coronary artery bypass grafting: Results of the EXPEDITION Study. *Ann Thorac Surgery*, 85(4):1261-1270, 2008.

92. Jolicoeur EM, Granger CB, Henry TD, Holmes DJ, Pepine CJ, Mark D, Chaitman BR, Gersh BJ, Ohman EM, on behalf of the Working Group Members. Clinical and research issues regarding chronic advanced coronary artery disease. Part I: contemporary and emerging therapies. *Am Heart J* 2008;155:418-34.

93. Jolicoeur EM, Ohman EM, Temple R, Stockbridge N, Mark D, Califf RM, Henry TD, Chaitman BR, Granger CB, on behalf of the Working Group Members. Clinical and research issues regarding chronic advanced coronary artery disease. Part II: trial design, outcomes, and regulatory issues. *Am Heart J* 2008;155:435-44.

94. Shaw LJ, Berman DS, Maron DJ, Mancini GBJ, Hayes SW, Hartigan PM, Weintraub WS, O'Rourke RA, Dada M, Spertus JA, Chaitman BR, Friedman J, Slomka P, Heller GV, Germano G, Gosselin G, Berger P, Kostuk WJ, Schwartz RG, Knudtson M, Veledar E, Bates ER, McCallister B, Teo KK, Boden WE, for the COURAGE Investigators. Optimal medical therapy with or without percutaneous coronary intervention to reduce ischemic burden: results from the COURAGE trial nuclear substudy. *Circulation* 2008;117:1283-1291.

95. Beller GA, Bonow RO, Fuster V, et al. ACCF 2008 Recommendations for Training in Adult Cardiovascular Medicine Core Cardiology Training (COCATS 3) (Revision of the 2002 COCATS Training Statement). *J Am Coll Cardiol* 2008;51:333-414.

96. Frey SE, Newman FK, Kennedy JS, Sobek V, Ennis FA, Hill H, Yan LK, Chaplin P, Vollmar J, Chaitman BR, Belshe RB. Clinical and immunologic responses to multiple doses of IMVAMUNE® (Modified Vaccinia Ankara) followed by Dryvax® challenge. *Vaccine* 2007;25:8562-8573.

97. Thygesen K, Alpert JS, White HD, on behalf of the Joint ESC/ACCF/AHA/WHF Task Force for the Redefition of Myocardial Infarction. Universal definition of myocardial infarction. *Eur Heart J* 2007;28:2525-2538; *Circulation* 2007;116: 2634-2653; *J Am Coll Cardiol* 2007;50:5173-5195.

98. Chaitman BR. An electrocardiogram should not be included in routine preparticipation screening of young athletes. *Circulation* 2007;116:2610-2615.

99. Boden WE, O'Rourke RA, Teo KK, Hartigan PM, Maron DJ, Kostuk WJ, Knudtson M, Dada M, Casperson P, Harris C, Chaitman BR, Shaw L, Gosselin G, Nawaz Sh, Title LM, Gau G, Blaustein AS, Booth DC, Bates ER, Spertus JA, Berman DS, Mancini GBJ, Weintraub WS, for the COURAGE Trial Research Group. Optimal medical therapy with or without PCI for stable coronary disease. *N Engl J Med* 2007;356:1503-16.

100. Scirica BM, Chaitman BR. Novel approaches to the treatment of chronic angina. *Clinical Geriatrics* 2007;15 (2; suppl 1):3-9.

101. Brooks MM, Alderman EL, Bates, E, Bourassa M, Califf RM, Chaitman BR, Detre KM, Feit F, Frye RL, Gibbons RJ, Hardison RM, Hlatky MA, Holmes DR, Jacobs AK, Kelsey SF, Krauland M, Rogers WJ, Schaff HV, Schwartz L, Sutton-Tyrrell K, Williams DO, Whitlow PK, the BARI Investigators. The final 10-year follow-up results from the BARI randomized trials. *J Am Coll Cardiol* 2007;49:1600-6.

102. Chaitman BR, Junko Sano. Novel therapeutic approaches to treating chronic angina in the setting of chronic ischemic heart disease. *Clin Cardiol* 2007;30:I25-I30.

103. Chaitman BR. Should early acceleration of heart rate during exercise be used to risk stratify patients with suspect or established coronary artery disease. *Circulation* 2007;115:430-431.

104. Boden WE, O'Rourke RA, Teo KK, Hartigan PM, Maron DJ, Kostuk W, Knudtson M, Dada M, Casperson P, Harris CL, Spertus JA, Shaw L, Chaitman BR, Mancini J, Berman DS, Gau G, Weintraub WS, on behalf of the COURAGE trial co-principal investigators and study coordinators. The evolving pattern of symptomatic coronary artery disease in the United States and Canada: Baseline Characteristics of the Clinical Outcomes Utilizing Revascularization and Aggressive DruG Evaluation (COURAGE) Trial. *Am J Cardiol* 2007;99:208-212.

105. Wenger NK, Chaitman BR, Vetrovec GW. Gender comparison of efficacy and safety of ranolazine for chronic angina pectoris in four randomized clinical trials. *Am J Cardiol* 2007;99:11-18.

106. Carson JL, Terrin ML, Magaziner J, Chaitman BR, Apple FS, Heck DA, Sanders D, for the FOCUS Investigators. Transfusion Trigger Trial for Functional Outcomes in Cardiovascular Patients Undergoing Surgical Hip Fracture Repair (FOCUS). *Transfusion* 2006;46:2192-2206.

107. Chaitman BR. Comments and discussion on the cocoa-platelet presentation. *J Cardiovasc Pharmacol* 2006;47:S206-S209.

108. Chaitman BR. When should ranolazine be considered for the treatment of chronic angina? *Nat Clin Practice Cardiovasc Med* 2006;3:590-591.

109. Chaitman BR. Ranolazine: Use in chronic angina and its potential use in other cardiovascular conditions**.** In Goodman & Gilman's The Pharmacological Basis of

Therapeutics, 11th Edition, Brunton LL, Parker KL, Buxton ILO, and Blumenthal DK ed., October 2006. http://www.accessmedicine.com/updatesContent.aspx?aid=1000974

110. Zipes DP, Camm AJ, Borggrefe M, Buxton AE, Chaitman BR, Fromer M, Gregoratos G, Klein GJ, Moss AJ, Myerburg RJ, Priori SG, Quinones MA, Roden DM, Silka MJ, Tracy CM. ACC/AHA/ESC 2006 guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death – **Executive Summary**: a report of the American College of Cardiology/ American Heart Association Task Force and the European Society of Cardiology Committee for Practice Guidelines (Writing Committee to Develop Guidelines for Management of Patient With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death). *J Am Coll Cardiol* 2006;48:1064-1108; *Circulation* 2006; 114:1088-1132. *Eur Heart J* 2006;27:2099-2140.

111. Zipes DP, Camm AJ, Borggrefe M, Buxton AE, Chaitman BR, Fromer M, Gregoratos G, Klein GJ, Moss AJ, Myerburg RJ, Priori SG, Quinones MA, Roden DM, Silka MJ, Tracy CM. ACC/AHA/ESC 2006 guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death. A report of the American College of Cardiology/ American Heart Association Task Force and the European Society of Cardiology Committee for Practice Guidelines (Writing Committee to Develop Guidelines for Management of Patient With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death). *J Am Coll Cardiol* 2006; 48:e247-e346; *Circulation* 2006;114:e385-e484; *Europace* 2006; 8:746–837.

112. Boden WE, O'Rourke RA, Teo KK, Hartigan PM, Maron DJ, Kostuk W, Knudtson M, Dada M, Casperson P, Harris CL, Spertus JA, Shaw L, Chaitman BR, Mancini GBJ, Berman DS, Weintraub WS on behalf of the COURAGE trial coinvestigators and study coordinators. Design and rationale of the Clinical Outcomes Utilizing Revascularization and Aggressive DruG Evaluation (COURAGE) trial: Veterans Affairs Cooperative Studies Program no. 424. *Am Heart J* 2006;151:1173-9.

113. Chaitman BR. Ranolazine for the treatment of chronic angina and potential use in other cardiovascular conditions. *Circulation* 2006; 113: 2462-2472.

114. Shaw LJ, Olson MB, Kip K, Kelsey SF, Johnson BD, Mark DB, Reis SE, Mankad S, Rogers WJ, Pohost GM, Arant C, Wessel T, Chaitman BR, Sopko G, Handberg E, Pepine CJ, Merz CNB. The value of estimated funcational capacity in estimating outcome: results from the National Heart, Lung and Blood Institute-sponsored Women's Ischemia Syndrome Evaluation. *J Am Coll Cardiol* 2006;47:36S-43S.

115. Johanson P, Armstrong PW, Barbagelata NA, Chaitman BR, Clemmensen P, Dellborg M, French J, Goodman SG, Green CL, Krucoff MW, Langer A, Pahlm O, Reilly P, Wagner GS. An academic ECG core lab perspective of the FDA initiative for digital ECG capture and data management in large-scale clinical trials. *Drug Information Journal* 2005;39:345-351.

116. Timmis A, Chaitman BR, Crager M. Effects of ranolazine on exercise tolerance and HbA1c in patients with chronic angina and diabetes. *Eur Heart J* 2006;27:42-48.

117. Vicari RM, Chaitman B, Keefe D, Smith WB, Chrysant SG, Tonkon MJ, Bittar N, Weiss RJ, Morales-Ballejo H, Thadani U, for the Fasudil Study group. Efficacy and safety of fasudil in patients with stable angina: a double-blind, placebo-controlled, phase 2 trial. *J Am Coll Cardiol* 2005;46:1803-1811.

118. Chaitman BR. Pharmacologic approaches to the symptomatic treatment of chronic stable angina: A historical perspective and future directions. *Can J Cardiol* 2005;21:1031-1034.

119. Chaitman BR, Ivleva AY, Ujda M, Lenis JHF, Toth C, Stieber DM, Reisin LH, Pangerl AM, Friedman JB, Lawrence JH. Antianginal efficacy of omapatrilat in patients with chronic angina pectoris. *Am J Cardiol* 2005;95:1283-1289.

120. Maron BJ, Zipes DP, Ackerman MJ, Balady GJ, Bonow RO, Chaitman BR, et al. 36th Bethesda Conference: Eligibility recommendations for competitive athletes with cardiovascular abnormalities. *J Am Coll Cardiol* 2005;45:1313-1375.

121. Lewis JF, McGorray S, Lin L, Pepine CJ, Chaitman B, Doyle M, Edmundowicz D, Sharaf BL, Merz CNB. Exercise treadmill testing using a modified exercise protocol in women with suspected myocardial ischemia: findings from the National Heart, Lung and Blood Institute-sponsored Women's Ischemia Syndrome Evaluation (WISE). *Am Heart J* 149:527-33, 2005.

122. Stevenson WG, Chaitman BR, Ellenbogen KA, Epstein AE, Gross WL, Hayes DL, Strickberger SA, Sweeney MO, for the Subcommittee on Electrocardiography and Arrhythmias of the American Heart Association Council on Clinical Cardiology, in Collaboration with the Heart Rhythm Society. Clinical assessment and management of patients with implanted cardioverter-defibrillators presenting to nonelectrophysiologists. *Circulation* 2004;110:3866-3869.

123. Chaitman BR, Lim MJ. No reflow and the quest to achieve optimal perfusion during the acute phase of myocardial infarction. *J Am Coll Cardiol* 2004;44:313-315.

124. Maron BJ, Chaitman B, Ackerman MJ, Bayes de Luna A, Corrado D, Crosson JE, Deal BJ, Driscoll DJ, Estes NAM, de Araujo CGS, Liang DH, Mitten MJ, Myerberg RJ, Pelliccia A, Thompson PD, Towbin JA, Van Camp SP, for the Working Groups of the American Heart Association Committee on Execise, Cardiac Rehabilitation, and Prevention; Councils on Clinical Cardiology and Cardiovascular Disease in the Young. Recommendations for physical activity and recreational sports participation for young patients with genetic cardiovascular diseases. *Circulation* 2004;109:2807-2816.

125. Chaitman BR, Skettino SL, Parker JO, Hanley P, Meluzin J, Kuch J, Pepine CJ, Wang W, Nelson JJ, Hebert DA, Wolff AA, for the Monotherapy Assessment of Ranolazine in Stable Angina (MARISA) Investigators. Anti-ischemic effects and long-term survival during ranolazine monotherapy in patients with chronic severe angina. *J Am Coll Cardiol* 2004;43:1375-1382.

126. Chaitman BR, Pepine CJ, Parker JO, Skopal J, Chumakova G, Kuch J, Wang W, Skettino SL, Wolff AA, for the Combination Assessment of Ranolazine In Stable Angina (CARISA) Investigators. Effects of ranolazine with atenolol, amlodipine, or diltiazem on exercise tolerance and angina frequency in patients with severe chronic angina. *JAMA* 291:309-316, 2004 .

127. Pepine CJ, Rouleau JL, Annis K, Ducharme A, Ma P, Lenis J, Davies R, Thadani U, Chaitman B, Haber HE, Freedman SB, Pressler ML, Pitt B. Effects of angiotensin-converting enzyme inhibition of transient ischemia: The Quinapril Anti-ischemia and Symptoms of Angina Reduction (QUASAR) Trial. *J Am Coll Cardiol* 2003;42:2049-2059.

128. Bailey WB, Chaitman BR. Electrocardiographic changes in intracranial hemorrhage mimicking myocardial infarction. *N Engl J Med* 2003;349:1874-75.

129. Chaitman BR. Abnormal heart rate responses to exercise predict increased long-term mortality regardless of coronary disease extent. The question is why? *J Am Coll Cardiol* 2003;42:839-41.

130. Boyce SW, Bartels C, Bolli R, Chaitman B, Chen JC, Chi E, Kereiakes D, Knight J, Thulin L,

Theroux P, on behalf of the GUARDIAN Study Investigators. Impact of sodium-hydrogen exchange inhibition by cariporide on death or myocardial infarction in high-risk CABG surgery patients: Results of the CABG Surgery Cohort of the GUARDIAN Study. *J Thoracic & Cardiovasc Surg* 2003;126:420-427.

131. Gavard JA, Chaitman BR, Sakai S, Stocke K, Danchin N, Erhardt L, Gallo R, Chi E, Jessel A, Theroux P, for the GUARd During Ischemia Against Necrosis (GUARDIAN) investigators. Prognostic significance of elevated CK-MB after coronary bypass surgery and after an acute coronary syndrome: results from the GUARDIAN trial. *J Thoracic & Cardiovascular Surgery* 2003;126:807-813.

132. Bailey WB, Chaitman BR. ECG changes mimicking infarction seen in intracranial hemorrhage. *N Engl J Med* 2003;394;561.

133. Pina IL, Apstein CS, Balady GJ, Belardinelli R, Chaitman BR, Duscha BD, Fletcher B, Fleg JL, Myers JN, Sullivan MJ. Exercise and heart failure. A statement from the Committee on Exercise, Rehabilitation and Prevention of the American Heart Association. *Circulation* 2003;107:1210-1225.

134. Chaitman BR. Measuring antianginal drug efficacy using exercise testing for chronic angina: Improved exercise performance with ranolazine, a pFox inhibitor. *Current Problems in Cardiology* 2002;27:527-555.

135. Chaitman BR. Update: Measuring antianginal drug efficacy using exercise testing for chronic angina. Improved exercise performance with a new class of drugs, the pFOX inhibitors. Hurst's The Heart 2002 (www.cardiology.accessmedicine.com).

136. Waters DD, Schwartz GG, Olsson AG, Zeiher A, Oliver MF, Ganz P, Ezekowitz M, Chaitman BR, Leslie SJ, Stern T, for the Myocardial Ischemia Reduction with Aggressive Cholesterol Lowering (MIRACL) Study Investigators. Effects of Atorvastatin on stroke in patients with unstable angina or non-Q-wave myocardial infarction: A Myocardial Ischemia Reduction with Aggressive Cholesterol Lowering (MIRACL) substudy. *Circulation* 2002;106:1690-1695.

137. Gibbons RJ, Balady GJ, Bricker JT, Chaitman BR, Fletcher GF, Froelicher VF, Mark DB, McCallister BD, Mooss AN, O'Reilly MG, Winters WL Jr. ACC/AHA 2002 guideline update for exercise testing: summary article. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to update the 1997 exercise testing guidelines). *Circulation* 2002;106:1883-1892.

138. Kip KE, Alderman EL, Bourassa MG, Brooks MM, Schwartz L, Holmes DR, Califf RM, Whitlow PL, Chaitman BR, Detre KM. Differential influence of diabetes mellitus on increased jeopardized myocardium after initial angioplasty or bypass surgery: The Bypass Angioplasty Revascularization Investigation. *Circulation* 2002;105:1914-1920.

139. Williams MA, Fleg JL, Ades PA, Chaitman BR, Miller NH, Mohiuddin SM, Ockene IS, Taylor CB, Wenger NK. Secondary prevention of coronary heart disease in the elderly (with emphasis on patients $\geq$ 75 years of age). An American Heart Association Scientific Statement from the Council on Clinical Cardiology Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention. *Circulation* 2002;105:1735-1743.

140. Beller GA, Bonow RO, Fuster V, et al. ACC revised recommendations for training in adult cardiovascular medicine core cardiology training II (COCATS 2) (Revision of the 1995 COCATS Training Statement). *J Am Coll Cardiol* 2002;39:1242-6.

141. Balady GJ, Chaitman B, Foster C, Froelicher E, Gordon N, Van Camp S. Automated external defibrillators in health/fitness facilities. Supplement to the AHA/ACSM recommendations for cardiovascular screening,

staffing, and emergency policies at health/fitness facilities. *Circulation* 2002;105:1147-1150.

142. Eagle KA, Berger PB, Calkins H, Chaitman BR, Ewy GA, Fleishmann KE, Fleisher LA, Froehlich JB, Gusberg RJ, Leppo JA, Ryan T, Schlant RC, Winters WL Jr. ACC/AHA guidelines for perioperative cardiovascular evaluation for noncardiac surgery update: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1996 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery). *J Am Coll Cardiol* 2002;39:542-53; *Anesthesia & Analgesia* 2002;94:1052-64;

143. Eagle KA, Berger PB, Calkins H, Chaitman BR, Ewy GA, Fleishmann KE, Fleisher LA, Froehlich JB, Gusberg RJ, Leppo JA, Ryan T, Schlant RC, Winters WL Jr. ACC/AHA guidelines for perioperative cardiovascular evaluation for noncardiac surgery update: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1996 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery). *Circulation* 2002;105:1257-1267.

144. Schwartz GG, Olsson AG, Ezekowitz MD, Ganz P, Oliver MF, Waters D, Zeiher A, Chaitman BR. Atorvastatin for acute coronary syndromes. *JAMA* 2001;286:533-5.

145. Klatte K, Chaitman BR, Theroux P, Gavard JA, Stocke K, Boyce S, Bartels C, Keller B, Jessel A, for the GUARDIAN Investigators. Increased mortality after coronary artery bypass grafting is associated with increased levels of postoperative CK-MB release – results from the GUARDIAN trial. *J Am Coll Cardiol* 2001;38:1070-7.

146. Bittl JA, Chaitman BR, Feit F, Kimball W, Topol E, on behalf of the Bivalirudin Angioplasty Study Investigators. Bivalirudin Versus Heparin During Coronary Angioplasty for Unstable or Post-Infarction Angina: The Final Report of the Bivalirudin Angioplasty Study. *Am Heart J* 2001;142:952-959.

147. Fletcher GF, Balady GJ, Amsterdam EA, Chaitman BR, Eckel R, Fleg J, Froelicher VF, Leon AS, Pina IL, Rodney R, Simons-Morton DG, Williams MA, Bazzarre T. AHA Scientific Statement - Exercise standards for testing and training. A statement for healthcare professionals from the American Heart Association. *Circulation* 2001;104:1694-1740.

148. Krone RJ, Hardison RM, Chaitman BR, Gibbons RJ, Sopko G, Bach R, Detre KM. Risk stratification after successful coronary revascularization: the lack of a role for routine exercise testing. *J Am Coll Cardiology* 2001;38:136-142.

149. The PRICE Investigators. Comparative 30-day economic and clinical outcomes of platelet glycoprotein IIb/IIIa inhibitor use during elective percutaneous coronary intervention: Prairie ReoPro Versus Integrilin Cost Evaluation (PRICE) trial. *Am Heart J* 2001;141:402-9.

150. Schwartz GG, Olsson AG, Ezekowitz MD, Ganz P, Oliver MF, Waters D, Zeiher A, Chaitman BR, Leslie S, Stern T, for the Myocardial Ischemia Reduction with Aggressive Cholesterol Lowering (MIRACL) Study Investigators. Effects of atorvastatin on early recurrent ischemic events in acute coronary syndromes. The MIRACL study: a randomized controlled trial. *JAMA* 2001;285:1711-1718.

151. Maron BJ, Araujo CGS, Thompson PD, Fletcher GF, Bayes de Luna A, Fleg JL, Pelliccia A, Balady GJ, Furlanello F, Van Camp SP, Elosua R, Chaitman BR, Bazzarre TL. Recommendations for preparticipation screening and the assessment of cardiovascular disease in master athletes. An advisory for healthcare professionals from the Working

Groups of the World Heart Federation, the International Federation of Sports Medicine, and the American Heart Association Committee on Exercise, Cardiac Rehabilitation, and Prevention. *Circulation* 2001;103:327-334.

152. Anderson ST, Pahlm O, Bacharova L, Barbagelata A, Chaitman BR, Clemmensen P, Goodman S, Heden B, Klootwijk PJ, Lauer M, MacFarlane PW, Rautaharju P, Reddy S, Selvester RH, Sgarbossa EB, Underwood D, Warner RA, Wagner GS. Standards for the function of an academic 12 lead electrocardiographic core laboratory. *J Electrocardiol* 34:41-47, 2001.

153. Gussak I, Wright RS, Bjerregaard P, Chaitman BR, Zhou SH, Hammill SC, Kopecky SL. False-negative and false-positive ECG diagnoses of Q wave myocardial infarction in the presence of right bundle-branch block. *Cardiology* 2000;94:165-72.

154. Myers WO, Berg R, Jefferson FR, Douglas-Jones JW, Maki H, Ulmer RH, Chaitman BR, Reinhart RA. All artery multi-graft coronary artery bypass grafting (CABG) with only internal thoracic arteries possible and safe: a randomized trial. *Surgery* 2000;128:650-9.

155. Gussak I, Brugada P, Brugada J, Wright RS, Kopecky SL, Chaitman BR, Bjerregaard P. Idiopathic Short QT Interval: A New Clinical Syndrome? *Cardiology* 2000;94:99-102.

156. Wagner G, Bahit MC, Criger D, Bayes de Luna A, Chaitman B, Clemmensen P, Klootwijk P, Marcus F, Pahlm O, Ohman M. Moving Toward a New Definition of Acute Myocardial Infarction for the 21st Century: Status of the ESC/ACC Consenus Conference. *J Electrocard* 33:57-59, 2000.

157. Theroux P, Chaitman BR, Danchin N, Erhardt L, Meinertz T, Schroeder JS, Tognoni G, White HD, Willerson JT, Jessel A for the GUARD During Ischemia Against Necrosis (GUARDIAN) Investigators: Inhibition of the Sodium-Hydrogen Exchanger with Cariporide to prevent Myocardial Infarction in High-Risk Ischemic Situations. Main Results of the GUARDIAN trial. *Circulation* 2000;102-3032-3038.

158. Yokoyama Y, Chaitman BR, Hardison RM, Guo P, Krone R, Stocke K, Gussak I, Attubato MJ, Rautaharju PM, Sopko G, Detre KM. Association between new ECG abnormalities after coronary revascularization and five year cardiac mortality in BARI randomized and registry patients. *Am J Cardiol* 2000;86:819-824.

159. Stein RA, Chaitman BR, Balady GJ, Fleg JL, Limacher MC, Pina IL, Williams MA, Bazzarre T. Safety and utility of exercise testing in emergency room chest pain centers. An advisory from the Committee on Exercise, Rehabilitation and Prevention, Council on Clinical Cardiology, American Heart Association. *Circulation* 2000;102:1463-67.

160. Fleg J, Piña IL, Balady G, Chaitman BR, Fletcher B, Lavie C, Limacher M, Stein R, Williams M, Bazzarre T. Assessment of functional capacity in clinical and research applications: an advisory from the Committee on Exercise, Rehabilitation and Prevention, Council on Clinical Cardiology. *Circulation* 2000;102(13):1591-1597.

161. The Joint European Society of Cardiology/American College of Cardiology Committee. Myocardial Infarction Redefined-A Consensus Document of The Joint European Society of Cardiology/American College of Cardiology Committee for the Redefinition of Myocardial Infarction. J Am Coll Cardiol 2000; 36(3):959-969; *Eur Heart J* 2000;21:1502-1513.

162. Theroux P, Chaitman BR, Erhardt L, Jessel A, Meinertz T, Nickel WU, Schroeder JS, Tognoni G, White H, Willerson JT. Design of a trial evaluating myocardial cell protection with cariporide, an inhibitor of the transmembrane sodium-hydrogen exchanger: the Guard During Ischemia Against Necrosis (GUARDIAN) trial.

Curr Control Trials Cardiovasc Med 2000;1:59-67.

163. Brooks MM, Jones RH, Bach RG, Chaitman BR, Kern MJ, Orszulak TA, Follmann D, Sopko G, Blackstone EH, Califf RM for the BARI investigators. Predictors of mortality and mortality from cardiac causes in the Bypass Angioplasty Revascularization Investigation (BARI) randomized trial and registry. *Circulation* 2000;101(23):2682-2689.

164. Alderman EL, Brooks MM, Bourassa M, Califf RM, Chaitman BR, Detre K, Faxon D, Frye R, Hardison RM, Hlatky M, Holubkov R, Jones RH, Kelsey SF, Schaff H, Shemin RJ, Sopko G, Sutton-Tyrell K, Williams DO. Seven year outcome in the Bypass Angioplasty Revascularization Investigation (BARI) by treatment and diabetic status. *J Am Coll Cardiol* 2000;35(5):1122-9.

165. Detre KM, Lombardero MS, Brooks MM, Hardison RM, Holubkov R, Sopko G, Frye RL, Chaitman BR. The effect of previous coronary-artery bypass surgery on the prognosis of patients with diabetes who have acute myocardial infarction. *N Engl J Med* 2000;342(14):989-97.

166. Gussak I, Chaitman BR, Kopecky SL, Nerbonne JM. Rapid ventricular repolarization in rodents: electrocardiographic manifestations, molecular mechanisms, and clinical insights. *J Electrocardiol* 2000;33(2):159-170.

167. Pollock ML, Franklin B, Balady GJ, Chaitman BR, Fleg JL, Fletcher B, Limacher M, Pina IL, Stein RA, Williams M, Bazzarre T. Resistance exercise in individuals with and without cardiovascular disease: benefits, rationale, safety, and prescription. An advisory from the Committee on Exercise, Rehabilitation, and Prevention, Council on Clinical Cardiology. *Circulation* 2000;101:828-833.

168. Pepine CJ, Mark DB, Bourassa MG, Chaitman BR, Davies RF, Knatterud GL, Forman S, Pratt CM, Sopko G, Conti CR. Cost estimates for treatment of cardiac ischemia: an ancillary study from the Asymptomatic Cardiac Ischemia Pilot (ACIP) study. *Am J Cardiol* 1999;84(11):1311-16.

169. Whitlow PL, Dimas AP, Bashore TM, Califf RM, Bourassa MG, Chaitman BR, Rosen AD, Kip KE, Stadius ML, Alderman EL for the BARI investigators. Relationship of extent of revascularization with angina at one year in the Bypass Angioplasty Revascularization Investigation (BARI). *J Am Coll Cardiol* 1999;34(6):1750-59.

170. Stone PH, Thompson B, Zaret BL, Chaitman B, Gibson RS, Schweiger MJ, Steingart R, Kirshenbaum J, Thompson C, Fung A, McCabe CH, Knatterud GL, Braunwald E for the TIMI-IIIB investigators. Factors associated with failure of medical therapy in patients with unstable angina and non-Q-wave MI: A TIMI-IIIB database study. *Eur Heart J* 1999;20(15):1084-1093.

171. Kip KE, Bourassa MG, Jacobs AK, Schwartz L, Feit F, Alderman EL, Weiner BH, Weiss MB, Kellett MA, Sharaf BL, Dimas AP, Jones RH, Sopko, Detre K, Chaitman BR and the BARI investigators. Influence of pre-PTCA strategy and initial PTCA result in patients with multivessel disease. The Bypass Angioplasty Revascularization Investigation (BARI). *Circulation* 1999;100:910-17.

172. Pepine CJ, Bourassa MG, Chaitman BR, Davies RF, Knatterud GL, Forman S, Pratt CM, Sopko G, Conti CR. Factors influencing clinical outcomes after early versus event-drive coronary revascularization: an Asymptomatic Cardiac Ischemia Pilot (ACIP) data bank study. *J Cardiac Surgery* 1999;14(1):1-8.

173. Gussak I, Zhou SH, Rautaharju P, Bjerregaard P, Stocke K, Osada N, Yokoyama Y, Miller M, Islam S, Chaitman BR. Right bundle branch block as a cause of false-negative ECG classification of inferior

myocardial infarction. *J Electrocardiol* 1999;32 (3): 279-84.

174. Bourassa MG, Kip KE, Jacobs AK, Jones RH, Sopko G, Rosen AD, Sharaf BL, Schwartz L, Chaitman BR, Alderman EL, Holmes DR, Roubin GS, Detre KM, Frye RL. Is a strategy of intended incomplete percutaneous transluminal coronary angioplasty revascularization acceptable in nondiabetic patients who are candidates for coronary artery bypass graft surgery? The Bypass Angioplasty Revascularization Investigation (BARI). *J Am Coll Cardiol* 1999; 33 (6): 1627-36.

175. Stone PH, Krantz DS, McMahon RP, Goldberg AD, Becker LC, Chaitman BR, Taylor HA, Cohen JD, Freedland KE, Bertolet BD, Coughlan C, Pepine CJ, Kaufmann PG, Sheps DS, the PIMI study group. Relationship among mental stress-induced ischemia and ischemia during daily life and during exercise: the Psychophysiologic Investigations of Myocardial Ischemia (PIMI) study. *J Am Coll Cardiol* 1999;33(6): 1476-1484.

176. Jacobs AK, Kelsey SF, Brooks MM, Faxon DP, Chaitman BR, Bittner V, Dean L, Mock MB, Weiner BH, Winston C, Drew L, Sopko G. Women versus men regarding outcome of CABG or PTCA-Response. *Circulation* 1999;99(14):1926.

177. Osada N, Chaitman BR. Letter to the editor. Peak V02 for prognosis in heart failure? Reply. *J Am Coll Cardiol* 1999;33(2):592.

178. Gussak I, Antzelevitch C, Bjerregaard P, Towbin JA, Chaitman BR. The Brugada Syndrome: clinical, electrophysiologic and genetic aspects. *J Am Coll Cardiol* 1999;33(1):5-15.

179. Gussak I, Liebl N, Bjerregaard P, Nouri S, Zimmerman F, Chaitman BR. Deceleration-dependent shortening of the QT interval: a new electrocardiographic phenomenon? *Clin Cardiol* 1999;22:124-26.

180. Piana RN, Ahmed WH, Chaitman B, Ganz P, Kinlay S, Strony J, Adelman B, Bittle JA and the Hirulog Angioplasty Study Investigators. Effect of transient abrupt vessel closure during otherwise successful angioplasty for unstable angina on clinical outcome at six months. *J Am Coll Card* 1999;33(1):73-78.

181. Jacobs AK, Kelsey SF, Brooks MM, Faxon DP, Chaitman BR, Bittner V, Mock MB, Weiner BH, Dean L, Winston C, Drew L, Sopko G. Better outcome for women as compared to men undergoing coronary revascularization: a report from the Bypass Angioplasty Revascularization Investigation (BARI). *Circulation* 1998;98:1279-1285.

182. Alderman EL, Levy JH, Rich JB, Nili M, Vidne B, Schaff H, Uretzky G, Pettersson G, Thiis JJ, Hantler CB, Chaitman B, Nadel A. Analyses of coronary graft patency after aprotinin use: Results from the International Multi-center Aprotinin Graft Patency Experience (IMAGE) Trial. *J Thorac Cardiovasc Surg* 1998;116:716-30.

183. Balady GJ, Chaitman B, Driscoll D, Foster C, Froelicher E, Gordon N, Pate R, Rippe J, Bazzare T. American Heart Association/American College of Sports Medicine Joint Scientific Statement: Recommendations for cardiovascular screening, staffing, and emergency policies at health/fitness facilities. *Circulation* 1998;97:2283-2293.

184. Balady GJ, Chaitman B, Driscoll D, Foster C, Froelicher E, Gordon N, Pate R, Rippe J, Bazzare T. American Heart Association/American College of Sports Medicine Joint Scientific Statement: Recommendations for cardiovascular screening, staffing, and emergency policies at health/fitness facilities. *Med Sci Sports Exerc* 1998;30:1009-1018.

185. Rautaharju PM, Park LP, Chaitman BR, Rautaharju F, Zhang ZM. The Novacode system for classification of electrocardiographic

abnormalties and their clinically significant progression and regression. *J Electrocardiology* 1998;31(3):157-187.

186. Sheps DS, McMahon RP, Pepine CJ, Stone PH, Goldberg AD, Taylor H, Cohen JD, Becker LC, Chaitman BR, Knatterud GL, Kaufmann PG for the PIMI investigators. The Psychophysiological Investigations of Myocardial Infarction (PIMI) study: heterogeneity among cardiac ischemia and anginal responses to exercise, mental stress and daily life. *Am J Cardiol* 1998;82(1):1-6.

187. Mahmarian JJ, Moye LA, Chinoy DA, Sequeira RF, Habib GB, Henry WJ, Jain A, Chaitman BR, Weng CS, Morales-Ballejo H, Pratt CM. Transdermal nitroglycerin patch therapy improves left ventricular function and prevents remodeling after acute myocardial infarction: results of a multicenter prospective randomized double-blind placebo controlled trial. *Circulation* 1998;97(20):2017-2025.

188. Pahlm US, Chaitman BR, Rautaharju PM, Selvester RH, Wagner GS. Comparison of the various electrocardiographic scoring codes for estimating anatomically documented sizes of single and multiple infarcts of the left ventricle. *Am J Cardiol* 1998;81:809-815.

189. Schwartz GG, Oliver MF, Ezekowitz MD, Ganz P, Waters D, Kane JP, Texter M, Pressler ML, Black D, Chaitman BR, Olsson AG. Rationale and design of the Myocardial Ischemia Reduction with Aggressive Cholesterol Lowering (MIRACL) study which evaluates atorvastatin in unstable angina pectoris and non Q wave acute myocardial infarction. *Am J Cardiol* 1998;81:578-581.

190. Handberg-Thurmond E, Baker A, Coglianese ME, Forman S, Pepine CJ, Geller N, Chaitman B. Identifying high yield sources of patients with coronary artery disease for clinical trials: lessons from the Asymptomatic Cardiac Ischemia Pilot (ACIP) experience. The ACIP Study Group. *Clinical Cardiology* 1998;21(3):177-82.

191. Mistry BM, Bastani B, Solomon H, Hoff J, Aridge DL, Lindsey LM, Schmid S, Chaitman BR, Garvin PJ. Prognostic value of dipyridamole thallium-201 screening to minimize perioperative cardiac complications in diabetics undergoing kidney or kidney-pancrease transplantation. *Clinical Transplantation* 1998;12(2):130-5.

192. Osada N, Chaitman BR, Miller LW, Yip D, Cishek MB, Wolford TL, Donohue TJ. Cardiopulmonary exercise testing identifies low risk heart failure patients with severe impaired exercise capacity considered for cardiac transplantation. *J Am Coll Cardiol* 1998;31:577-82.

193. Kaufmann PG, McMahon RP, Becker LC, Bertolet B, Bonstall R, Chaitman B, Cohen J, Forman S, Goldberg A, Freedland K, Ketterer MW, Krantz DS, Pepine CJ, Raczynski J, Stone PH, Taylor H, Knatterud GL, and Sheps DS. The psychophysiological investigations of myocardial ischemia (PIMI) study: objectives, methods and variability of measures. *Psychosomatic Medicine* 1998;60:56-63.

194. Califf R, Abdelmeguid AE, Kuntz R, Popma JJ, Davidson CJ, Cohen EA,Kleiman NS, Mahaffey KW, Topol EJ, Pepine CJ, Lipicky R, Granger CB, Herrington RA, Tardiff BE, Crenshaw D, Bauman RP, Zuckerman D, Chaitman BR, Bittl JA, Ohman EM. Myonecrosis after revascularization procedures. *J Am Coll Cardiol* 1998;31:241-51.

195. Bora PS, Miller DD, Chaitman BR. Mutagenesis and characterization of specific residues in fatty acid ethyl ester synthase: a gene for alcohol-induced cardiomyopathy. *Molecular & Cellular Biochemistery* 1998;180:111-115.

196. Sharaf B, Bourassa M, McMahon R, Pepine C, Chaitman B, Williams D, Davies R, Proschan M, Conti R. Clinical and detailed angiographic

findings in patients with ambulatory electrocardiographic ischemia without critical coronary narrowing: results from the Asymptomatic Cardiac Ischemic Pilot (ACIP) study. *Clinical Cardiology* 1998;21:86-92.

197. Polak MJ, Zhou SH, Rautaharju PM, Armstrong WW, Chaitman BR. Using automated analysis of the resting 12 lead ECG to identify patients at risk of developing transient myocardial ischemia-an application of adaptive logic network. *Physiol. Meas*. 1997;18:317-25.

198. Stone PH, Chaitman BR, Forman S, Andrews TC, Bittner V, Bourassa MG, Davies RF, Deanfield JE, Frishman W, Goldberg AD, MacCallum G, Ouyang P, Pepine CJ, Pratt CM, Sharaf B, Steingart R, Knatterud GL, Sopko G, Conti CR. Prognostic significance of myocardial ischemia detected by ambulatory electrocardiogram, exercise treadmill testing, and resting electrocardiogram to predict cardiac events by 1 year (The Asymptomatic Cardiac Ischemia Pilot (ACIP) Study). *Am J Cardiol* 1997;80:1395-1401.

199. Conti CR, Geller NL, Knatterud GL, Forman SA, Pratt CM, Pepine CJ, Sopko G for the ACIP Investigators. Anginal status and prediction of cardiac events in patients enrolled in the Asymptomatic Cardiac Ischemia Pilot (ACIP) Study. *Am J Cardiol* 1997;79:889-892.

200. Chaitman BR, Rosen AD, Williams DO, Bourassa MG, Aguirre FV, Pitt B, Rautaharju PM, Rogers WJ, Sharaf B, Attubato M, Hardison RM, Srivatsa S, Kouchoukos NT, Stocke K, Sopko G, Detre K, Frye R for the BARI investigators. Cardiac mortality and myocardial infarction in the Bypass Angioplasty Revascularization (BARI) Randomized Trial. *Circulation* 1997;96(7):2162-2170.

201. Alderman E, Bourassa N, Califf R, Chaitman B, Faxon D, Feit F, Frye R. The influence of diabetes on 5 year mortality and morbidity in a randomized trial comparing CABG and PTCA in patients with multivessel disease: the Bypass Angioplasty Revascularization Investigation (BARI). *Circulation* 1997;96(6):1761-1769.

202. Eagle KA, Brundage BH, Chaitman BR, Ewy GA, Fleisher LA, Hertzer NR, Leppo JA, Ryan T, Schlant RC, Spencer WH 3rd, Spittell JA Jr, Twiss RD. Guidelines for perioperative cardiovascular evaluation for noncardiac surgery: an abridged version of the report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Mayo Clinic Proceedings* 1997;72(6):524-31.

203. Sloan MA, Price TR, Terrin ML, Forman S, Gore JM, Chaitman BR, Hodges M, Mueller H, Rogers WJ, Knatterud GL, Braunwald E. Ischemic cerebral infarction after rt-PA and heparin therapy for acute myocardial infarction. The TIMI-II pilot and randomized clinical trial combined experience. *Stroke* 1997;28(6):1107-14.

204. Bora PS, Guruge BL, Miller DD, Chaitman BR, Fortson W. Human fatty acid ethyl ester synthase-III gene: Genomic organization, nucleotide sequencing and chromosomal localization. *Mol Cell Biochem* 173:145-151, 1997.

205. Merritt R, Guruge BL, Miller DD, Chaitman BR, Bora PS. Moderate alcohol feeding attenuates postinjury vascular cell proliferation in rabbit angioplasty model. *J Cardiovasc Pharmacology* 1997;30:19-25.

206. Alderman E, Andrews K, Brooks MM, Detre K, Kelsey SF, Rosen AD, Sutton-Tyrrell K, Bourassa M, Chaitman BR , et al for the Writing Group for the Bypass Angioplasty Revascularization Investigation (BARI). Five-year clinical and functional outcome comparing bypass surgery and angioplasty in patients with multivessel coronary disease. *JAMA* 1997;277:715-21.

207. Osada N, Chaitman BR, Donohue TJ, Wolford TL, Stelken AM, Miller LW. Long-term cardiopulmonary exercise performance after

heart transplantation. *Am J Cardiol* 1997;79(4):451-456.

208. Cannon CP. McCabe CH. Stone PH. Schactman M. Thompson B. Theroux P. Gibson RS. Feldman T. Kleiman NS. Tofler GH. Muller JE. Chaitman BR. Braunwald E. Circadian variation in the onset of unstable angina and non-Q-wave acute myocardial infarction (the TIMI III Registry and TIMI IIIB). *Am J Cardiol* 79(3):253-8, 1997.

209. Miller DD, Younis LT, Chaitman BR, Stratmann H. Diagnostic accuracy of dipyridamole technetium 99m-labeled sestamibi myocardial tomography for detection of coronary artery disease. *J Nuclear Cardiol* 1997;4:18-24.

210. Taylor HA Jr. Mickel MC. Chaitman BR. Sopko G. Cutter GR. Rogers WJ. Long-term survival of African Americans in the Coronary Artery Surgery Study (CASS). *J Am Coll Cardiol* 29(2):358-64, 1997.

211. Bora PS, Guruge BL, Miller DD, Chaitman BR, Ruyle MS. Purification and characterization of human heart fatty acid ethyl ester synthase/ carboxylesterase. *J Mol Cell Cardiol* 28: 2027-2032, 1996.

212. Chaitman BR. Zhou SH. Tamesis B. Rosen A. Terry AB. Zumbehl KM. Stocke K. Takase B. Gussak I. Rautaharju PM. Methodology of serial ECG classification using an adaptation of the NOVACODE for Q wave myocardial infarction in the Bypass Angioplasty Revascularization Investigation (BARI). *J Electrocardiol* 29(4):265-77, 1996.

213. Chaitman BR. Left ventricular ejection fraction: an important but incomplete determinant of long-term outcome after coronary bypass surgery [editorial]. *Eur Heart J* 17(6):817-8, 1996.

214. Stone PH. Chaitman BR. McMahon RP. Andrews TC. MacCallum G. Sharaf B. Frishman W. Deanfield JE. Sopko G. Pratt C. Goldberg AD. Rogers WJ. Hill J. Proschan M. Pepine CJ. Bourassa MG. Conti CR. Asymptomatic Cardiac Ischemia Pilot (ACIP) Study. Relationship between exercise-induced and ambulatory ischemia in patients with stable coronary disease. *Circulation* 94(7):1537-44, 1996.

215. Pepine CJ, Bourassa MG, Chaitman BR, Conti CR, Geller NL, Knatterud GL, Pratt CM, Rogers WJ, Sopko G for the ACIP investigators. Letter to the editor. *J Am Coll Cardiol* 1996;27:1315-8.

216. Shaw LJ. Miller DD. Romeis JC. Younis LT. Gillespie KN. Kimmey JR. Chaitman BR. Prognostic value of noninvasive risk stratification in younger and older patients referred for evaluation of suspected coronary artery disease. *Journal of the American Geriatrics Society*. 44(10):1190-7, 1996.

217. The Bypass Angioplasty Revascularization Investigation (BARI) Investigators. Comparison of coronary bypass surgery with angioplasty in patients with multivessel disease. *N Engl J Med* 335:217-225, 1996.

218. Caracciolo EA. Chaitman BR. Forman SA. Stone PH. Bourassa MG. Sopko G. Geller NL. Conti CR. Diabetics with coronary disease have a prevalence of asymptomatic ischemia during exercise treadmill testing and ambulatory ischemia monitoring similar to that of nondiabetic patients. An ACIP database study. ACIP Investigators. Asymptomatic Cardiac Ischemia Pilot Investigators. *Circulation* 93(12): 2097-105, 1996.

219. Bora PS. Farrar MA. Miller DD. Chaitman BR. Guruge BL. Myocardial cell damage by fatty acid ethyl esters. *J Cardiovascular Pharmacology* 27(1): 1-6, 1996.

220. Eagle KA. Brundage BH. Chaitman BR. Ewy GA. Fleisher LA. Hertzer NR. Leppo JA. Ryan T. Schlant RC. Spencer WH 3rd. Spittell JA Jr. Twiss RD. Ritchie JL. Cheitlin MD. Gardner TJ. Garson A Jr. Lewis RP. Gibbons

RJ. O'Rourke RA. Ryan TJ. Guidelines for perioperative cardiovascular evaluation for noncardiac surgery. Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Committee on Perioperative Cardiovascular Evaluation for Noncardiac Surgery. *Circulation*. 93(6):1278-317, 1996. *J Am Coll Cardiol* 1996;27(4): 910-48.

221. Donohue TJ. Miller DD. Bach RG. Tron C. Wolford T. Caracciolo EA. Aguirre FV. Younis LT. Chaitman BR. Kern MJ. Correlation of poststenotic hyperemic coronary flow velocity and pressure with abnormal stress myocardial perfusion imaging in coronary artery disease. *Am J Cardiology* 77(11): 948-54, 1996.

222. Stelken AM. Younis LT. Jennison SH. Miller DD. Miller LW. Shaw LJ. Kargl D. Chaitman BR. Prognostic value of cardiopulmonary exercise testing using percent achieved of predicted peak oxygen uptake for patients with ischemic and dilated cardiomyopathy. Journal of the American College of *Cardiology*. 27(2):345-52, 1996.

223. Fletcher GF, Balady G, Blair SN, Blumenthal J, Caspersen C, Chaitman BR, Epstein S, Sivarajan Froelicher ES, Froelicher VF, Pina I, Pollock ML. Statement on exercise: benefits and recommendations for physical activity programs for all Americans. A statement for health professionals by the Committee on Exercise Cardiac Rehabilitation of the Council on Clinical Cardiology, American Heart Association. *Circulation* 94:857-862, 1996.

224. Bourassa MG. Knatterud GL. Pepine CJ. Sopko G. Rogers WJ. Geller NL. Dyrda I. Forman SA. Chaitman BR. Sharaf B. et al. Asymptomatic Cardiac Ischemia Pilot (ACIP) Study. Improvement of cardiac ischemia at 1 year after PTCA and CABG. *Circulation*. 92(9 Suppl):II1-7, 1995.

225. Rogers W, Bourassa M, Andrews T, Bertolet B, Blumenthal B, Chaitman B, Dymond D, Forman S, Geller N, Goldberg D, Habib G, Masters R, Moisa R, Mueller H, Pearce D, Pepine C, Selwyn A, Sopko G, Steingart R, Stone P, Conti CR for the ACIP investigators. Asymptomatic Cardiac Ischemia Pilot (ACIP) Study: 1 year follow-up. J Am Coll Cardiol 1995;26:594-605 and presented at the 67th Annual Scientific Sessions of the American Heart Association. *Circulation* 1994;90:I-17.

226. Bittl JA. Strony J. Brinker JA. Ahmed WH. Meckel CR. Chaitman BR. Maraganore J. Deutsch E. Adelman B. Treatment with bivalirudin (Hirulog) as compared with heparin during coronary angioplasty for unstable or postinfarction angina. Hirulog Angioplasty Study Investigators. *N Eng J Med* 333 (12):764-9, 1995.

227. Bourassa MG. Pepine CJ. Forman SA. Rogers WJ. Dyrda I. Stone PH. Chaitman BR. Sharaf B. Mahmarian J. Davies RF. et al. Asymptomatic Cardiac Ischemia Pilot (ACIP) study: effects of coronary angioplasty and coronary artery bypass graft surgery on recurrent angina and ischemia. The ACIP investigators. *J Am Coll Cardiol* 26(3):606-14, 1995.

228. Rogers WJ. Bourassa MG. Andrews TC. Bertolet BD. Blumenthal RS. Chaitman BR. Forman SA. Geller NL. Goldberg AD. Habib GB. et al. Asymptomatic Cardiac Ischemia Pilot (ACIP) study: outcome at 1 year for patients with asymptomatic cardiac ischemia randomized to medical therapy or revascularization. The ACIP Investigators. *J Am Coll Cardiol* 26(3):594-605, 1995.

229. Chaitman BR. Stone PH. Knatterud GL. Forman SA. Sopko G. Bourassa MG. Pratt C. Rogers WJ. Pepine CJ. Conti CR. Asymptomatic Cardiac Ischemia Pilot (ACIP) study: impact of anti-ischemia therapy on 12-week rest electrocardiogram and exercise test outcomes. The ACIP Investigators. *J Am Coll Cardiol* 26(3):585-93, 1995.

230. Cannon CP. Thompson B. McCabe CH. Mueller HS. Kirshenbaum JM. Herson S. Nasmith JB. Chaitman BR. Braunwald E. Predictors of non-Q-wave acute myocardial infarction in patients with acute ischemic syndromes: an analysis from the Thrombolysis in Myocardial Ischemia (TIMI) III trials. *Am J Cardiol* 75(15):977-81, 1995.

231. Aguirre FV. Younis LT. Chaitman BR. Ross AM. McMahon RP. Kern MJ. Berger PB. Sopko G. Rogers WJ. Shaw L. et al. Early and 1-year clinical outcome of patients' evolving non-Q-wave versus Q-wave myocardial infarction after thrombolysis. Results from The TIMI II Study. *Circulation* 91(10):2541-8, 1995.

232. Weiner DA. Ryan TJ. Parsons L. Fisher LD. Chaitman BR. Sheffield LT. Tristani FE. Long-term prognostic value of exercise testing in men and women from the Coronary Artery Surgery Study (CASS) registry. *Am J Cardiol* 75(14):865-70, 1995.

233. Caracciolo EA. Davis KB. Sopko G. Kaiser GC. Corley SD. Schaff H. Taylor HA. Chaitman BR. Comparison of surgical and medical group survival in patients with left main equivalent coronary artery disease. Long-term CASS experience. *Circulation* 91(9):2335-44, 1995.

234. Caracciolo EA. Davis KB. Sopko G. Kaiser GC. Corley SD. Schaff H. Taylor HA. Chaitman BR. Comparison of surgical and medical group survival in patients with left main coronary artery disease. Long-term CASS experience. *Circulation* 91(9):2325-34, 1995.

235. Rogers WJ. Alderman EL. Chaitman BR. DiSciascio G. Horan M. Lytle B. Mock MB. Rosen AD. Sutton-Tyrrell K. Weiner BH. et al.Bypass Angioplasty Revascularization Investigation (BARI): baseline clinical and angiographic data. *Am J Cardiol* 75(9):9C-17C, 1995.

236. Kern MJ, Donohue TJ, Aguirre FV, Bach RG, Caracciolo EA, Wolford T, Mechem C, Flynn MS, Chaitman BR. Clinical outcome of deferring angioplasty in patients with normal translesional pressure flow velocity measurements. *J Am Coll Cardio*l 1995;25:178-87.

237. Davis KB, Chaitman BR, Ryan T, Bittner V, Kennedy JW. Comparison of 15 year survival for men and women after initial medical or surgical treatment for coronary artery disease: a CASS registry study. *J Am Coll Cardiol* 1995;25:1000-1009.

238. Weiner DA. Ryan TJ. Parsons L. Fisher LD. Chaitman BR. Sheffield LT. Tristani FE.Significance of silent myocardial ischemia during exercise testing in women: report from the Coronary Artery Surgery Study. *Am Heart J* 129(3):465-70, 1995.

239. Chaitman BR, Miller DD. Diagnostic and prognostic exercise electrocardiography: what can nuclear cardiology gain from insights from the exercise laboratory-challenge and speculation. *J Nucl Cardiol* 1995;2:267-270.

240. Polak MJ, Zhou SH, Rautaharju PM, Armstrong WW, Chaitman BR. Adaptive logic network compared with back propagation network in automated detection of ischemia from resting ECG. *Computers in Cardiology* 1995;217-200.

241. Alpert JS. Arnold WJ. Chaitman BR. Conti CR. Ewy GA. Michelson EL. Myerburg RJ. Guidelines for training in adult cardiovascular medicine. Core Cardiology Training Symposium (COCATS). Task Force 1: training in clinical cardiology. *J Am Coll Cardiol.* 25(1):4-9, 1995.

242. Conti CR. Bourassa MG. Chaitman BR. Geller NL. Knatterud GL. Pepine CJ. Pratt C. Sopko G. Asymptomatic cardiac ischemia pilot (ACIP). *Transactions of the American Clinical & Climatological Association*. 106:77-83; discussion 83-4, 1994.

243. Emond M. Mock MB. Davis KB. Fisher LD. Holmes DR Jr. Chaitman BR. Kaiser GC. Alderman E. Killip T 3rd. Long-term survival of medically treated patients in the Coronary Artery Surgery Study (CASS) Registry. *Circulation* 90(6):2645-57, 1994.

244. Younis L. Stratmann H. Takase B. Byers S. Chaitman BR. Miller DD. Preoperative clinical assessment and dipyridamole thallium-201 scintigraphy for prediction and prevention of cardiac events in patients having major noncardiovascular surgery and known or suspected coronary artery disease. *Am J Cardiol* 74(4):311-7, 1994.

245. Aguirre FV. McMahon RP. Mueller H. Kleiman NS. Kern MJ. Desvigne-Nickens P. Hamilton WP. Chaitman BR. Impact of age on clinical outcome and postlytic management strategies in patients treated with intravenous thrombolytic therapy. Results from the TIMI II Study. TIMI II Investigators. *Circulation* 90(1):78-86, 1994.

246. Knatterud GL. Bourassa MG. Pepine CJ. Geller NL. Sopko G. Chaitman BR. Pratt C. Stone PH. Davies RF. Rogers WJ. et al. Effects of treatment strategies to suppress ischemia in patients with coronary artery disease: 12-week results of the Asymptomatic Cardiac Ischemia Pilot (ACIP) study. *J Am Coll Cardiol* 24(1):11-20, 1994.

247. Pepine CJ. Geller NL. Knatterud GL. Bourassa MG. Chaitman BR. Davies RF. Day P. Deanfield JE. Goldberg AD. McMahon RP. et al. The Asymptomatic Cardiac Ischemia Pilot (ACIP) study: design of a randomized clinical trial, baseline data and implications for a long-term outcome trial [published erratum appears in *J Am Coll Cardiol* 1995 Sep;26(3):842]. *J Am Coll Cardiol* 24(1):1-10, 1994.

248. Miller DD. Donohue TJ. Younis LT. Bach RG. Aguirre FV. Wittry MD. Goodgold HM. Chaitman BR. Kern MJ. Correlation of pharmacological 99mTc-sestamibi myocardial perfusion imaging with poststenotic coronary flow reserve in patients with angiographically intermediate coronary artery stenoses. *Circulation* 89(5):2150-60, 1994.

249. Shaw LJ. Miller DD. Romeis JC. Kargl D. Younis LT. Chaitman BR. Gender differences in the noninvasive evaluation and management of patients with suspected coronary artery disease. Annals Internal Med. 120(7):559-66, 1994.

250. The TIMI II Investigators. Effects of tissue plasminogen activator and a comparison of early invasive and conservative strategies in unstable angina and non Q wave myocardial infarction. Results of the TIMI IIIB trial. *Circulation* 1994;89:1545-56.

251. Miller DD, Stratmann HG, Shaw L, Tamesis BR, Wittry MD, Younis LT, Chaitman BR. Dipyridamole technetium 99m sestamibi myocardial tomography as an independent predictor of cardiac event-free survival after acute ischemic events. *J Nucl Cardiol 1994;1:172-82.*

252. Weiner DA, Ryan TJ, Parsons L, Fisher LD, Chaitman BR, Sheffield LT, Tristani FE. CAD progression and exercise test reproducibility in patients with silent ischemia. *J Myocardial Ischemia* 1994;6:29.

253. Diver EJ, Bier JD, Ferreira PE, Sharaf BL, McCabe C, Thompson B, Chaitman BR, Williams DO, Braunwand E for the TIMI IIIA Investigators. Clinical and arteriographic characterization of patients with unstable angina without critical coronary arterial narrowing: (From the TIMI IIIA Trial). *Am J Cardiol* 1994;74:531-37.

254. Stratmann HG. Williams GA. Wittry MD. Chaitman BR. Miller DD. Exercise technetium-99m sestamibi tomography for cardiac risk stratification of patients with stable chest pain. *Circulation* 89(2):615-22, 1994.

255. Dahms TE. Younis LT. Wiens RD. Zarnegar S. Byers SL. Chaitman BR. Effects of carbon

monoxide exposure in patients with documented cardiac arrhythmias. *J Am Coll Cardiol* 21(2):442-50, 1993.

256. Tamesis B. Stelken A. Byers S. Shaw L. Younis L. Miller DD. Chaitman BR. Comparison of the Asymptomatic Cardiac Ischemia Pilot and modified Asymptomatic Cardiac Ischemia Pilot versus Bruce and Cornell exercise protocols. *Am J Cardiol* 72(9):715-20, 1993.

257. Takase B. Younis LT. Byers SL. Shaw LJ. Labovitz AJ. Chaitman BR. Miller DD. Comparative prognostic value of clinical risk indexes, resting two-dimensional echocardiography, and dipyridamole stress thallium-201 myocardial imaging for perioperative cardiac events in major nonvascular surgery patients. *Am Heart J* 126(5):1099-106, 1993.

258. Alderman EL. Corley SD. Fisher LD. Chaitman BR. Faxon DP. Foster ED. Killip T. Sosa JA. Bourassa MG. Five-year angiographic follow-up of factors associated with progression of coronary artery disease in the Coronary Artery Surgery Study (CASS). CASS Participating Investigators and Staff. *J Am Coll Cardiol* 22(4):1141-54, 1993.

259. Taylor HA. Chaitman BR. Rogers WJ. Kern MJ. Terrin ML. Aguirre FV. Sopko G. McMahon R. Ross RN. Bovill EC. Race and prognosis after myocardial infarction. Results of the thrombolysis in myocardial infarction (TIMI) phase II trial. *Circulation* 88(4 Pt 1):1484-94, 1993.

260. Albert SG. Gomez CR. Russell S. Chaitman BR. Bernbaum M. Kong BA. Cerebral and ophthalmic artery hemodynamic responses in diabetes mellitus. *Diabetes Care* 16(2):476-82, 1993.

261. The TIMI IIIA Investigators. Early effects of tissue-type plasminogen activator added to conventional therapy on the culprit coronary lesion in patients presenting with ischemic cardiac pain at rest. Results of the Thrombolysis in Myocardial Ischemia (IIIA) Trial. *Circulation* 1993;87:38-52.

262. Chaitman BR. McMahon RP. Terrin M. Younis LT. Shaw LJ. Weiner DA. Frederick MM. Knatterud GL. Sopko G. Braunwald E. Impact of treatment strategy on predischarge exercise test in the Thrombolysis in Myocardial Infarction (TIMI) II Trial. *Am J Cardiol* 71(2):131-8, 1993.

263. Chaitman BR. Dahms TE. Byers S. Carroll LW. Younis LT. Wiens RD. Carbon monoxide exposure of subjects with documented cardiac arrhythmias. Research Report - Health Effects Institute. (52):1-26; discussion 27-37, 1992.

264. Shaw L. Miller DD. BA. Hilton T. Stelken A. Stocke K. Chaitman BR. Determination of perioperative cardiac risk by adenosine thallium-201 myocardial imaging. *Am Heart J* 124(4):861-9, 1992.

265. Caralis DG. Shaw L. Bilgere B. Younis L. Stocke K. Wiens RD. Chaitman BR. Application of computerized exercise ECG digitization. Interpretation in large clinical trials. *Journal of Electrocardiology.* 25(2):101-10, 1992.

266. Kong BA. Shaw L. Miller DD. Chaitman BR. Comparison of accuracy for detecting coronary artery disease and side-effect profile of dipyridamole thallium-201 myocardial perfusion imaging in women versus men. *Am J Cardiol* 70(2):168-73, 1992.

267. Hsia J. Kleiman N. Aguirre F. Chaitman BR. Roberts R. Ross AM. Heparin-induced prolongation of partial thromboplastin time after thrombolysis: relation to coronary artery patency. HART Investigators. *J Am Coll Cardiol* 20(1):31-5, 1992.

268. Kleiman NS, Terrin M, Mueller, Chaitman B, Roberts R, Braunwald E, Knatterud GL, Solomon R, McMahon RP, and the TIMI investigators. Mechanisms of early death

despite thrombolytic therapy: experience from the Thrombolysis in Myocardial Infarction Phase II (TIMI II) study. *J Am Coll Cardiol* 1992;19:1129-1135.

269. Fletcher GF, Blair SN, Blumenthal J, Caspersen C, Chaitman B, Epstein S, Falls H, Wivarajan-Froelicher ES, Froelicher VF, Pina IL, Members. Statement on exercise. Benefits and recommendations for physical activity-programs for all Americans. A statement for health professionals by the Committee on Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology, American Heart Association. *Circulation* 1992; 86: 340-344.

270. The ACIP Investigators. Asymptomatic Cardiac Ischemic Pilot Study (ACIP). *Am J Cardiol* 1992; 70:744-747.

271. Shaw L. Chaitman BR. Hilton TC. Stocke K. Younis LT. Caralis DG. Kong BA. Miller DD. Prognostic value of dipyridamole thallium-201 imaging in elderly patients. *J Am Coll Cardiol* 19(7): 1390-8, 1992.

272. Rautaharju PM. Calhoun HP. Chaitman BR. NOVACODE serial ECG classification system for clinical trials and epidemiologic studies. *J Electrocardiology.* 24 Suppl:179-87, 1991.

273. Fagan LF Jr. Shaw L. Kong BA. Caralis DG. Wiens RD. Chaitman BR. Prognostic value of exercise thallium scintigraphy in patients with good exercise tolerance and a normal or abnormal exercise electrocardiogram and suspected or confirmed coronary artery disease. *Am J Cardiol*. 69(6):607-11, 1992.

274. Hilton TC. Shaw LJ. Chaitman BR. Stocke KS. Goodgold HM. Miller DD. Prognostic significance of exercise thallium-201 testing in patients aged greater than or equal to 70 years with known or suspected coronary artery disease. *Am J Cardiol* 69(1):45-50, 1992.

275. Aguirre FV. Kern MJ. Hsia J. Serota H. Janosik D. Greenwalt T. Ross AM. Chaitman BR. Importance of myocardial infarct artery patency on the prevalence of ventricular arrhythmia and late potentials after thrombolysis in acute myocardial infarction. *Am J Cardiol* 68(15):1410-6, 1991.

276. Weiner DA. Ryan TJ. Parsons L. Fisher LD. Chaitman BR. Sheffield LT. Tristani FE. Significance of silent myocardial ischemia during exercise testing in patients with diabetes mellitus: a report from the Coronary Artery Surgery Study (CASS) Registry. *Am J Cardiol* 68(8):729-34, 1991.

277. Allred EN, Bleecker ER, Chaitman BR, Dahms TE, Gottlieb SO, Hackney JD, Pagano M, Selvester RH, Walden SM, Warren J. Effects of carbon monoxide on myocardial ischemia. *Environmental Health Perspectives* 1991;91:89-132.

278. Younis LT, Walker H, Peterson G, Chaitman BR. Predicting perioperative and long-term cardiac risk in peripheral vascular disease. *Cardiology Board Review* 1991;8(5):36-45.

279. BARI Investigators. Protocol for the bypass angioplasty revascularization investigation. *Circulation* 1991; 84(suppl V):V1-V27.

280. Thadani U, Zellner SR, Glasser S, Bittar N, Montoro R, Miller AB, Chaitman BR, Schulmann P, Stahl A, DiBianco R, Bray J, Means WE, Morledge J. Double-blind, dose-response, placebo-controlled multicenter study of nisoldipine. A new second generation calcium channel blocker in angina pectoris. *Circulation* 1991; 84: 2398-2408.

281. White CW, Chaitman BR, Knudtson ML, Chisholm RJ, Vandormael M, Schmidt DH, Morton BC, Armstrong PW, Khaja F, Roy L, Kern M, Lassar T, Kirchner P, Freeman M, Port S, Maloney B, Marcus ML. Antiplatelet agents are effective in reducing the acute ischemic complications of angioplasty but do not prevent restenosis: results from the ticlopidine trial. *Coronary Art Dis* 1991;2:757-67.

282. Weiner DA. Ryan TJ. Parsons L. Fisher LD. Chaitman BR. Sheffield LT. Tristani FE. Prevalence and prognostic significance of silent and symptomatic ischemia after coronary bypass surgery: a report from the Coronary Artery Surgery Study (CASS) randomized population. *J Am Coll Cardiol* 18(2):343-8, 1991.

283. Allred EN. Bleecker ER. Chaitman BR. Dahms TE. Gottlieb SO. Hackney JD. Pagano M. Selvester RH. Walden SM. Warren J. Effects of carbon monoxide on myocardial ischemia. Environmental Health Perspectives. 91:89-132, 1991.

284. Hilton TC. Chaitman BR. The prognosis in stable and unstable angina. *Cardiology Clinics* 9(1):27-38, 1991.

285. Hsia J. Hamilton WP. Kleiman N. Roberts R. Chaitman BR. Ross AM. A comparison between heparin and low-dose aspirin as adjunctive therapy with tissue plasminogen activator for acute myocardial infarction. Heparin-Aspirin Reperfusion Trial (HART) Investigators. *N Eng J Med* 323 (21): 1433-7, 1990.

286. Shaw LJ. Younis LT. Stocke KS. Sharma AK. Chaitman BR. Effects of posture on metabolic and hemodynamic predischarge exercise response after acute myocardial infarction. *Am J Cardiol* 66(2):134-9, 1990.

287. Chaitman BR. Thompson BW. Kern MJ. Vandormael MG. Cohen MB. Ruocco NA. Solomon RE. Braunwald E. Tissue plasminogen activator followed by percutaneous transluminal coronary angioplasty: one-year TIMI phase II pilot results. TIMI Investigators. *American Heart Journal*. 119 (2 Pt 1):213-23, 1990.

288. Caralis DG. Wiens G. Shaw L. Younis LT. Haueisen ME. Wiens RD. Chaitman BR. An off-line digital system for reproducible interpretation of the exercise ECG. *J Electrocardiology* 23(4): 285-91, 1990.

289. Chaitman BR. Ryan TJ. Kronmal RA. Foster ED. Frommer PL. Killip T. Coronary Artery Surgery Study (CASS): comparability of 10 year survival in randomized and randomizable patients. *J Am Coll Cardiol* 16(5):1071-8, 1990.

290. Younis LT. Chaitman BR. Update on intravenous dipyridamole cardiac imaging in the assessment of ischemic heart disease. *Clinical Cardiology* 13(1):3-10, 1990.

291. Camp AD. Garvin PJ. Hoff J. Marsh J. Byers SL. Chaitman BR. Prognostic value of intravenous dipyridamole thallium imaging in patients with diabetes mellitus considered for renal transplantation. *Am J Cardiol* 65(22):1459-63, 1990.

292. Younis LT. Aguirre F. Byers S. Dowell S. Barth G. Walker H. Carrachi B. Peterson G. Chaitman BR. Perioperative and long-term prognostic value of intravenous dipyridamole thallium scintigraphy in patients with peripheral vascular disease. *Am Heart J* 119(6):1287-92, 1990.

293. Deligonul U. Vandormael MG. Younis LT. Chaitman BR. Prognostic significance of silent myocardial ischemia detected by early treadmill exercise after coronary angioplasty. *Am J Cardiol* 64 (1):1-5, 1989.

294. Deligonul U, Vandormael M, Shah Y, Galan K, Kern MJ, Chaitman BR. Exercise test after percutaneous transluminal coronary angioplasty: functional and prognostic implications. Cardiovascular Review and Reports, 1989.

295. Labovitz AJ. Lewen M. Kern MJ. Vandormael M. Mrosek DG. Byers SL. Pearson AC. Chaitman BR. The effects of successful PTCA on left ventricular function: assessment by exercise echocardiography. *Am Heart J* 117(5):1003-8, 1989.

296. Stone PH. Chaitman BR. McMahon RP. Andrews TC. MacCallum G. Sharaf B.

Frishman W. Deanfield JE. Sopko G. Pratt C. Goldberg AD. Rogers WJ. Hill J. Proschan M. Pepine CJ. Bourassa MG. Conti CR. Asymptomatic Cardiac Ischemia Pilot (ACIP) Study. Relationship between exercise-induced and ambulatory ischemia in patients with stable coronary disease. *Circulation* 94(7):1537-44, 1996.

297. Chaitman BR. More on the saga of routine emergency coronary angioplasty for acute myocardial infarction. J Am Coll Cardiol 13(6):1260-1, 1989.

298. Deligonul U. Vandormael MG. Shah Y. Galan K. Kern MJ. Chaitman BR. Prognostic value of early exercise stress testing after successful coronary angioplasty: importance of the degree of revascularization. Am Heart J 117(3):509-14, 1989.

299. Chaitman BR. Thompson B. Wittry MD. Stump D. Hamilton WP. Hillis LD. Dwyer JG. Solomon RE. Knatterud GL. The use of tissue-type plasminogen activator for acute myocardial infarction in the elderly: results from thrombolysis in myocardial infarction Phase I, open label studies and the Thrombolysis in Myocardial Infarction Phase II pilot study. The TIMI Investigators. *J Am Coll Cardiol* 14(5):1159-65, 1989.

300. Allred EN. Bleecker ER. Chaitman BR. Dahms TE. Gottlieb SO. Hackney JD. Pagano M. Selvester RH. Walden SM. Warren J. Short-term effects of carbon monoxide exposure on the exercise performance of subjects with coronary artery disease. *N Eng J Med* 321(21):1426-32, 1989.

301. Zack PM. Chaitman BR. Davis KB. Kaiser GC. Wiens RD. Ng G. Survival patterns in clinical and angiographic subsets of medically treated patients with combined proximal left anterior descending and proximal left circumflex coronary artery disease (CASS). *Am Heart J* 118(2):220-7, 1989.

302. Allred EN. Bleecker ER. Chaitman BR. Dahms TE. Gottlieb SO. Hackney JD. Hayes D. Pagano M. Selvester RH. Walden SM. et al. Acute effects of carbon monoxide exposure on individuals with coronary artery disease. Research Report - Health Effects Institute. (25):1-79, 1989.

303. Younis LT. Byers S. Shaw L. Barth G. Goodgold H. Chaitman BR. Prognostic importance of silent myocardial ischemia detected by intravenous dipyridamole thallium myocardial imaging in asymptomatic patients with coronary artery disease. *J Am Coll Cardiol* 14(7):1635-41, 1989.

304. Weiner DA. Ryan TJ. McCabe CH. Ng G. Chaitman BR. Sheffield LT. Tristani FE. Fisher LD. The role of exercise-induced silent myocardial ischemia in patients with abnormal left ventricular function. A report from the Coronary Artery Surgery Study (CASS) registry. *Am Heart J* 118(4):649-54, 1989.

305. Pryor DB. Bruce RA. Chaitman BR. Fisher L. Gajewski J. Hammermeister KE. Pauker SG. Stokes J 3d. Task Force I: Determination of prognosis in patients with ischemic heart disease. *J Am Coll Cardiol* 14(4):1016-25, 1989.

306. Taylor HA. Deumite NJ. Chaitman BR. Davis KB. Killip T. Rogers WJ. Asymptomatic left main coronary artery disease in the Coronary Artery Surgery Study (CASS) registry. *Circulation*. 79(6):1171-9, 1989.

307. Younis LT. Byers S. Shaw L. Barth G. Goodgold H. Chaitman BR. Prognostic value of intravenous dipyridamole thallium scintigraphy after an acute myocardial ischemic event. *Am J Cardiol* 64(3):161-6, 1989.

308. Camp A. Chaitman BR. Goodgold H. Byers S. Shaw L. Barth G. Samuels L. Intravenous dipyridamole: body weight considerations and dosage requirements. *A Heart J* 117(3):702-4, 1989.

309. Galan KM, Deligonul U, Kern MJ, Chaitman BR, Vandormael MG. Quitting smoking reduces risk of restenosis after PTCA. *J Critical Illness* 1989;4:16.

310. The TIMI Study Group. Comparison of invasive and conservative strategies after treatment with intravenous tissue plasminogen activator in acute myocardial infarction: Results of the Thrombolysis in Myocardial Infarction (TIMI) Phase I trial. *N Engl J Med* 1989;320:618-27.

311. Stoddard MF. Chaitman BR. Byers SL. Mrosek D. Labovitz AJ. Noninvasive assessment of diastolic and systolic properties of ibopamine in patients with congestive heart failure. *Am Heart J* 117(2):395-402, 1989.

312. Chaitman BR. Posterior myocardial infarction revisited [editorial]. *J Am Coll Cardiol* 12(5):1167-8, 1988.

313. Deligonul U. Vandormael MG. Kern MJ. Zelman R. Galan K. Chaitman BR. Coronary angioplasty: a therapeutic option for symptomatic patients with two and three vessel coronary disease. *J Am Coll Cardiol* 11(6):1173-9, 1988.

314. Labovitz AJ, Pearson AC, Mrosek DG, Chaitman BR. Stress Doppler echocardiography. *Dynamic Cardiovasc Imaging* 4:257-263, 1988.

315. Galan KM. Deligonul U. Kern MJ. Chaitman BR. Vandormael MG. Increased frequency of restenosis in patients continuing to smoke cigarettes after percutaneous transluminal coronary angioplasty. *Am J Cardiol* 61(4):260-3, 1988.

316. Weiner DA. Ryan TJ. McCabe CH. Chaitman BR. Sheffield LT. Ng G. Fisher LD. Tristini FE. Comparison of coronary artery bypass surgery and medical therapy in patients with exercised-induced silent myocardial ischemia: a report from the Coronary Artery Surgery Study (CASS) registry. *J Am Coll Cardiol* 12(3):595-9, 1988.

317. Labovitz AJ. Pearson AC. Chaitman BR. Doppler and two-dimensional echocardiographic assessment of left ventricular function before and after intravenous dipyridamole stress testing for detection of coronary artery disease. Am J Cardiol 62(17):1180-5, 1988.

318. Weiner DA. Ryan TJ. McCabe CH. Ng G. Chaitman BR. Sheffield LT. Tristani FE. Fisher LD. Risk of developing an acute myocardial infarction or sudden coronary death in patients with exercise-induced silent myocardial ischemia. A report from the Coronary Artery Surgery Study (CASS) registry. *Am J Cardiol* 62(17):1155-8, 1988.

319. Bruce RA. Fisher LD. Pettinger M. Weiner DA. Chaitman BR. ST segment elevation with exercise: a marker for poor ventricular function and poor prognosis. Coronary Artery Surgery Study (CASS) confirmation of Seattle Heart Watch results. *Circulation* 77(4):897-905, 1988.

320. Vandormael M, Deligonul U, Gabliani G, Chaitman BR, Kern MJ. Percutaneous balloon valvuloplasty and coronary angioplasty for the treatment of calcific aortic stenosis and obstructive coronary artery disease in an elderly patient. *Catheter & Cardiovasc Diag* 14:49-52.

321. Lam JY. Chaitman BR. Glaenzer M. Byers S. Fite J. Shah Y. Goodgold H. Samuels L. Safety and diagnostic accuracy of dipyridamole-thallium imaging in the elderly. *J Am Coll Cardiol* 11(3):585-9, 1988.

322. Vandormael MG. Deligonul U. Kern MJ. Harper M. Presant S. Gibson P. Galan K. Chaitman BR. Multilesion coronary angioplasty: clinical and angiographic follow-up. *J Am Coll Cardiol* 10(2): 246-52, 1987.

323. Weiner DA. Ryan TJ. McCabe CH. Chaitman BR. Sheffield LT. Fisher LD. Tristani F.

Value of exercise testing in determining the risk classification and the response to coronary artery bypass grafting in three-vessel coronary artery disease: a report from the Coronary Artery Surgery Study (CASS) registry. *Am J Cardiol* 60(4):262-6, 1987.

324. Crean PA. Waters DD. Lam J. Chaitman BR. Comparative antianginal effects of nisoldipine and nifedipine in patients with chronic stable angina. *Am Heart J* 113(2 Pt 1):261-5, 1987.

325. Passamani E, Hodges, Herman M, Mueller H, Chaitman B, Rogers W, Forman S, Terrin M, Knatterud G, Robertson T, Braunwald E. The thrombolysis in myocardial infarction (TIMI) phase II pilot: tissue plasminogen activator followed by percutaneous transluminal coronary angioplasty. *J Am Coll Cardiol* 1987;10:51B-64B.

326. Lewen MK. Labovitz AJ. Kern MJ. Chaitman BR. Prolonged myocardial ischemia after intravenous dipyridamole thallium imaging. *Chest* 92(6):1102-4, 1987.

327. Goodgold HM. Rehder JG. Samuels LD. Chaitman BR. Improved interpretation of exercise Tl-201 myocardial perfusion scintigraphy in women: characterization of breast attenuation artifacts. *Radiology* 165(2):361-6, 1987.

328. Weiner DA. Ryan TJ. McCabe CH. Luk S. Chaitman BR. Sheffield LT. Tristani F. Fisher LD. Significance of silent myocardial ischemia during exercise testing in patients with coronary artery disease. *Am J Cardiol* 59(8):725-9, 1987.

329. Buckingham TA. Ghosh S. Homan SM. Thessen CC. Redd RM. Stevens LL. Chaitman BR. Kennedy HL. Independent value of signal-averaged electrocardiography and left ventricular function in identifying patients with sustained ventricular tachycardia with coronary artery disease. *Am J Cardiology* 59(6):568-72, 1987.

330. Mehdirad AA. Williams GA. Labovitz AJ. Bryg RJ. Chaitman BR. Evaluation of left ventricular function during upright exercise: correlation of exercise Doppler with postexercise two-dimensional echocardiographic results. *Circulation*. 75(2):413-9, 1987.

331. Robert J. Bourassa MG. Moise A. Kouz S. Crepeau J. Bonan R. Chaitman BR. David PR. Salamon R. Risk of preangioplasty occlusion and myocardial infarction in one-vessel-disease patients scheduled for percutaneous transluminal coronary angioplasty. *Catheterization & Cardiovascular Diagnosis*. 12(5):292-7, 1986.

332. Geschwind H. Fabre M. Chaitman BR. Lefebvre-Villardebo M. Ladouch A. Boussignac G. Blair JD. Kennedy HL. Histopathology after Nd-YAG laser percutaneous transluminal angioplasty of peripheral arteries. *J Am Coll Cardiol* 8(5):1089-95, 1986.

333. Chaitman BR. The changing role of the exercise electrocardiogram as a diagnostic and prognostic test for chronic ischemic heart disease. *J Am Coll Cardiol* 8(5):1195-210, 1986.

334. Chaitman BR. Davis KB. Dodge HT. Fisher LD. Pettinger M. Holmes DR. Kaiser GC. Should airline pilots be eligible to resume active flight status after coronary bypass surgery?: a CASS registry study. *J Am Coll Cardiol* 8(6):1318-24, 1986.

335. Chaitman BR. Davis KB. Kaiser GC. Mudd G. Wiens RD. Ng GS. Passamani ER. Killip T. The role of coronary bypass surgery for 'left main equivalent' coronary disease: the Coronary Artery Surgery Study registry. *Circulation* 74(5 Pt 2):III17-25, 1986.

336. Weiner DA. Ryan TJ. McCabe CH. Chaitman BR. Sheffield LT. Fisher LD. Tristani F. The role of exercise testing in identifying patients with improved survival after coronary artery

bypass surgery. *J Am Coll Cardiol* 8(4):741-8, 1986.

337. Bryg RJ, Labovitz AJ, Mehdirad AA, Williams GA, Chaitman BR. Effect of coronary artery disease on Doppler-derived parameters of aortic flow during upright exercise. *Am J Cardiol* 58(1):14-9, 1986.

338. Schlichtig R, Cowden WL, Chaitman BR. Tolerance of unusually low mixed venous oxygen saturation. Adaptations in the chronic low cardiac output syndrome. *Am J Med* 80(5):813-8, 1986.

339. Lam JC, Chaitman BR, Hanson JS, Bernard P, Bourassa MG. Comparative diagnostic value of exercise polarcardiography and 14-lead electrocardiography in the detection of coronary artery disease. *Am Heart J* 110(6):1237-41, 1985.

340. Vandormael MG, Chaitman BR, Ischinger T, Aker UT, Harper M, Hernandez J, Deligonul U, Kennedy HL. Immediate and short-term benefit of multilesion coronary angioplasty: influence of degree of revascularization. *J Am Coll Cardiol* 6(5): 983-91, 1985.

341. Ryan TJ. Weiner DA. McCabe CH. Davis KB. Sheffield LT. Chaitman BR. Tristani FE. Fisher LD. Exercise testing in the Coronary Artery Surgery Study randomized population. *Circulation* 72 (6 Pt 2):V31-8, 1985.

342. Lam J. Chaitman BR. Crean P. Blum R. Waters DD. A dose-ranging, placebo-controlled, double-blind trial of nisoldipine in effort angina: duration and extent of antianginal effects. *J Am Coll Cardiol* 6(2): 447-52, 1985.

343. Hung J. Chaitman BR. Lam J. Lesperance J. Dupras G. Fines P. Cherkaoui O. Robert P. Bourassa MG. A logistic regression analysis of multiple noninvasive tests for the prediction of the presence and extent of coronary artery disease in men. Am Heart J. 110(2):460-9, 1985.

344. Weiner DA and principal investigators. Accuracy of cardiomyopathy during exercise testing: results of a multicenter study. *J Am Coll Cardiol* 1985;6:502-509.

345. Weiner DA. Ryan TJ. McCabe CH. Chaitman BR. Sheffield LT. Ferguson JC. Fisher LD. Tristani F. Prognostic importance of a clinical profile and exercise test in medically treated patients with coronary artery disease. *J Am Coll Cardiol* 3(3):772-9, 1984.

346. Jamieson WR. Pelletier LC. Janusz MT. Chaitman BR. Tyers FO. Miyagishima RT. Five-year evaluation of the Carpentier-Edwards porcine bioprosthesis. *J Thoracic & Cardiovascular Surgery* 88(3):324-33, 1984.

347. Chaitman BR. Wagniart P. Pasternac A. Brevers G. Scholl JM. Lam J. Methe M. Ferguson RJ. Bourassa MG. Improved exercise tolerance after propranolol, diltiazem or nifedipine in angina pectoris: comparison at 1, 3 and 8 hours and correlation with plasma drug concentration. *Am J Cardiol* 53(1):1-9, 1984.

348. Schaff HV. Gersh BJ. Fisher LD. Frye RL. Mock MB. Ryan TJ. Ells RB. Chaitman BR. Alderman EL. Kaiser GC. et al. Detrimental effect of perioperative myocardial infarction on late survival after coronary artery bypass. Report from the Coronary Artery Surgery Study--CASS. *J Thoracic & Cardiovascular Surgery* 88(6):972-81, 1984.

349. Weiner DA. Ryan TJ. McCabe CH. Chaitman BR. Sheffield LT. Ferguson JC. Fisher LD. Tristani F. The value of preoperative exercise testing in predicting long-term survival in patients undergoing aortocoronary bypass surgery. *Circulation* 70(3 Pt 2):I226-31, 1984.

350. Chaitman BR. Brevers G. Dupras G. Lesperance J. Bourassa MG. Diagnostic impact of thallium scintigraphy and cardiac fluoroscopy when the exercise ECG is strongly positive. *Am Heart J* 108(2):260-5, 1984.

351. Hung J. Chaitman BR. Lam J. Lesperance J. Dupras G. Fines P. Bourassa MG. Noninvasive diagnostic test choices for the evaluation of coronary artery disease in women: a multivariate comparison of cardiac fluoroscopy, exercise electrocardiography and exercise thallium myocardial perfusion scintigraphy. *J Am Coll Cardiol* 4(1):8-16, 1984.

352. Pomar JL. Bosch X. Chaitman BR. Pelletier C. Grondin CM. Late tears in leaflets of porcine bioprostheses in adults. *Annals of Thoracic Surgery*37(1):78-83,1984.

353. Hung J, Chaitman B. Post myocardial infarction stress tests: when? What do they show? *J Cardiovasc Med* 1984;9:417-31.

354. Pomar JL, Bosch X, Chaitman BR, Pelletier GL, Grondon GM. Late tears of porcine valvular bioprostheses in the adult. *Ann Thor Surg* 1984;37:78-83.

355. CASS Principal Investigators and their associates. Myocardial infarction and mortality in the Coronary Artery Surgery Study (CASS) randomized trial. *N Engl J Med* 1984;310:750-58.

356. CASS Principal Investigators and their associates. Coronary Artery Surgery Study (CASS). A randomized trial of coronary artery bypass surgery. Comparability of entry characteristics and survival in randomized patients and nonrandomized patients meeting randomization criteria. *J Am Coll Cardiol* 1984;3:114-128.

357. Sami M, Chaitman B, Alderman E, Watson L, Tristani F, Maloney P, Harada S, Litwin P, Fisher L. Significance of exercise induced ventricular arrhythmia in patients with stable coronary artery disease (CASS). *Am J Cardiol* 1984;54:1182-1188.

358. Lam J, Chaitman BR. Exercise lead systems and newer electrocardiographic parameters. *J Cardiac Rehab* 1984;IV:507-516.

359. Bernard P, Chaitman BR, Scholl JM, Val PG, Chabot M. Comparative diagnostic performance of the Telemed computer ECG program. *J Electrocardiology* 16(1):97-103, 1983.

360. Pelletier C. Martin-Albo C. Castonguay Y. Chaitman BR. [Valve replacement in aged patients. Risk and remote results]. [French] *Archives des Maladies du Coeur et des Vaisseaux* 76(9):1039-46, 1983.

361. Waters DD. Chaitman BR. Szlachcic J. Theroux P [Must the medical treatment of vasospastic angina be continued indefinitely?]. [French] *Archives des Maladies du Coeur et des Vaisseaux* 76 Spec No:161-8, 1983.

362. Guiteras Val P. Pelletier LC. Hernandez MG. Jais JM. Chaitman BR. Dupras G. Solymoss BC. Diagnostic criteria and prognosis of perioperative myocardial infarction following coronary bypass. *J Thoracic & Cardiovascular Surgery* 86(6):878-86, 1983.

363. Pelletier LC. Castonguay YR. Chaitman BR. Open-heart surgery in elderly patients. *Canadian Medical Association Journal* 128(4):409-12, 1983.

364. Chaitman BR. Alderman EL. Sheffield LT. Tong T. Fisher L. Mock MB. Weins RD. Kaiser GC. Roitman D. Berger R. Gersh B. Schaff H. Bourassa MG. Killip T. Use of survival analysis to determine the clinical significance of new Q waves after coronary bypass surgery. *Circulation* 67(2): 302-9, 1983.

365. Chaitman BR. Davis K. Fisher LD. Bourassa MG. Mock MB. Lesperance J. Rogers WJ. Fray D. Tyras DH. Judkins MP. et al. A life table and Cox regression analysis of patients with combined proximal left anterior descending and proximal left circumflex coronary artery disease: non-left main equivalent lesions (CASS). *Circulation* 68(6):1163-70, 1983.

366. CASS Principal Investigators and their associates. Coronary Artery Surgery Study (CASS). A randomized trial of coronary artery bypass surgery. Quality of life in patients randomly assigned to treatment groups. *Circulation* 1983;68:951-960.

367. Ringqvist I. Fisher LD. Mock M. Davis KB. Wedel H. Chaitman BR. Passamani E. Russell RO Jr. Alderman EL. Kouchoukas NT. Kaiser GC. Ryan TJ. Killip T. Fray D. Prognostic value of angiographic indices of coronary artery disease from the Coronary Artery Surgery Study (CASS). *J Clinical Investigation* 71(6):1854-66, 1983.

368. Betriu A. Chaitman BR. Bourassa MG. Brevers G. Scholl JM. Bruneau P. Gagne P. Chabot M. Beneficial effect of intravenous diltiazem in the acute management of paroxysmal supraventricular tachyarrhythmias. *Circulation* 67(1):88-94, 1983.

369. Garcia-Dorado D. Miller DD. Garcia EJ. Delcan JL. Maroto E. Chaitman BR. An epidemic of pulmonary hypertension after toxic rapeseed oil ingestion in Spain. *J Am Coll Cardiol* 1(5):1216-22, 1983.

370. Puddu PE. Bernard PM. Chaitman BR. Bourassa MG. QT interval measurement by a computer assisted program: a potentially useful clinical parameter. *J Electrocardiology* 15(1):15-21, 1982.

371. Ryan TJ, Fisher LD, Weiner DA, McCabe CH, Chaitman BR, Kennedy JW, Ferguson RJ, Tristani F. The use of ECG exercise testing in evaluating patients with ischemic heart disease. *Kardiologiia Moskva* 1982;22:26.

372. Rogers WJ, Chaitman BR, Fisher LD, Bourassa MG, Davis K, Maynard CL, Tyras DH, Berger RL, Judkins MP, Ringqvist I, Mock MB, Killip T. Comparison of the cumulative survival of medically and surgically treated patients with left main coronary artery disease: the CASS experience. U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, NIH Publication No. 82-1965, 1982, pp 107-120.

373. Weiner DA, McCabe CM, Ryan TJ, Chaitman BR, Sheffield LT, Ferguson J, Fisher LF. Assessment of the negative exercise test in 4373 patients from the Coronary Artery Surgery Study (CASS). *J Cardiac Rehab* 1982;2:562-568.

374. Fournier M. Ricci J. Taylor AW. Ferguson RJ. Montpetit RR. Chaitman BR. Skeletal muscle adaptation in adolescent boys: sprint and endurance training and detraining. *Medicine & Science in Sports & Exercise* 14(6):453-6, 1982.

375. Scholl JM. Chaitman BR. David PR. Dupras G. Brevers G. Val PG. Crepeau J. Lesperance J. Bourassa MG. Exercise electrocardiography and myocardial scintigraphy in the serial evaluation of the results of percutaneous transluminal coronary angioplasty. *Circulation* 66(2):380-90, 1982.

376. Brevers G. Scholl JM. Chaitman BR. Dupras G. David PR. Lesperance J. Bernard P. Val PG. Bourassa MG. [Importance of the exercise electrocardiogram and of thallium scintigraphy of the myocardium in the evaluation of patients referred for percutaneous transluminal coronary angioplasty]. [French] *Union Medicale du Canada* 111(1):32-6, 78, 1982.

377. David PR. Bourassa MG. Lesperance J. Scholl JM. Crepeau J. Dyrda I. Hudon G. Chaitman BR. Dupras G. Pelletier C. Maille JG. Paquet E. [Coronary percutaneous transluminal angioplasty: initial results in our first 110 patients]. [French] *Union Medicale du Canada* 111(1):23-30, 78, 1982.

378. Zimmern SH. Rogers WJ. Bream PR. Chaitman BR. Bourassa MG. Davis KA. Tyras DH. Berger R. Fisher L. Judkins MP. Mock MB. Killip TA. Total occlusion of the left main coronary artery: the Coronary Artery Surgery Study (CASS) experience. *Am J Cardiol* 49(8):2003-10, 1982.

379. Mock MB. Ringqvist I. Fisher LD. Davis KB. Chaitman BR. Kouchoukos NT. Kaiser GC. Alderman E. Ryan TJ. Russell RO Jr. Mullin S. Fray D. Killip T 3d. Survival of medically treated patients in the coronary artery surgery study (CASS) registry. *Circulation* 66(3):562-8, 1982.

380. Rogers WJ. Chaitman BR. Fisher LD. Bourassa MG. Davis K. Maynard Ch. Tyras DH. Berger RL. Judkins MP. Ringqvist I. Mock MB. Killip Th. [Comparison of the cumulative survival among patient groups with a left main coronary artery lesion after surgical and therapeutic treatment]. [Russian] *Kardiologiia* 22(2):53-7, 1982.

381. Danchin N. David P. Bourassa MG. Robert P. Chaitman BR. Factors predicting working status after aortocoronary bypass surgery. *Canadian Medical Association Journal* 126(3):255-60, 1982.

382. Pelletier C. Chaitman BR. Baillot R. Val PG. Bonan R. Dyrda I. Clinical and hemodynamic results with the Carpentier-Edwards porcine bioprosthesis. *Annals of Thoracic Surgery* 34(6):612-24, 1982.

383. Delcan JL. Chaitman BR. Lopez-Bescos L. Bonan R. Garcia-Dorado D. Rivera R. Hemodynamic evaluation of the Angell-Shiley porcine xenograft. *Journal of Thoracic & Cardiovascular Surgery* 84(2):297-305, 1982.

384. Wagniart P. Ferguson RJ. Chaitman BR. Achard F. Benacerraf A. Delanguenhagen B. Morin B. Pasternac A. Bourassa MG. Increased exercise tolerance and reduced electrocardiographic ischemia with diltiazem in patients with stable angina pectoris. Circulation. 66(1):23-8, 1982.

385. Guiteras P. Chaitman BR. Waters DD. Bourassa MG. Scholl JM. Ferguson RJ. Wagniart P. Diagnostic accuracy of exercise ECG lead systems in clinical subsets of women. Circulation. 65(7):1465-74, 1982.

386. Ryan TJ, Fisher LD, Weiner DA, McCabe CH, Chaitman BR, Kennedy JW, Ferguson RJ, Tristani F. Experience with electrocardiographic exercise testing in the coronary artery surgery study (CASS). U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, NIH Publication #82-1965, May 1982, pp 83-91.

387. Bernard P. Chaitman BR. Scholl JM. Chabot M. [Value of the automated analysis of the electrocardiogram by the Telemed program (V version)]. [French] Archives des Maladies du Coeur et des Vaisseaux. 74(10):1155-62, 1981.

388. Chaitman BR. Fisher LD. Bourassa MG. Davis K. Rogers WJ. Maynard C. Tyras DH. Berger RL. Judkins MP. Ringqvist I. Mock MB. Killip T. Effect of coronary bypass surgery on survival patterns in subsets of patients with left main coronary artery disease. Report of the Collaborative Study in Coronary Artery Surgery (CASS). American Journal of Cardiology. 48(4):765-77, 1981.

389. Berger RL. Davis KB. Kaiser GC. Foster ED. Hammond GL. Tong TG. Kennedy JW. Sheffield T. Ringqvist I. Wiens RD. Chaitman BR. Mock M. Preservation of the myocardium during coronary artery bypass grafting. Circulation. 64(2 Pt 2):II61-6, 1981.

390. Chaitman BR. Bourassa MG. Davis K. Rogers WJ. Tyras DH. Berger R. Kennedy JW. Fisher L. Judkins MP. Mock MB. Killip T. Angiographic prevalence of high-risk coronary artery disease in patient subsets (CASS). Circulation. 64(2):360-7, 1981.

391. Fisher LD. Kennedy JW. Chaitman BR. Ryan TJ. McCabe C. Weiner D. Tristani F. Schloss M. Warner HR Jr. Diagnostic quantification of CASS (coronary artery surgery study) clinical and exercise test results in determining presence and extent of coronary artery disease. A

multivariate approach. Circulation. 63(5):987-1000, 1981.

392. Tubau JF. Chaitman BR. Bourassa MG. Lesperance J. Dupras G. Importance of coronary collateral circulation in interpreting exercise test results. American Journal of Cardiology. 47(1):27-32, 1981.

393. Du Cailar C. Chaitman BR. Castonguay Y. Risks and benefits of aortocoronary bypass surgery in patients aged 65 years or more. Canadian Medical Association Journal. 122(7):771-4, 1980.

394. Chaitman BR. Rogers WJ. Davis K. Tyras DH. Berger R. Bourassa MG. Fisher L. StoverHertzberg V. Judkins MP. Mock MB. Killip T. Operative risk factors in patients with left main coronary-artery disease. New England Journal of Medicine. 303(17):953-7, 1980.

395. Waters DD. Chaitman BR. Bourassa MG. Tubau JF. Clinical and angiographic correlates of exercise-induced ST-segment elevation. Increased detection with multiple ECG leads. Circulation. 61(2):286-96, 1980.

396. Tubau JF. Chaitman BR. Bourassa MG. Waters DD. Detection of multivessel coronary disease after myocardial infarction using exercise stress testing and multiple ECG lead systems. Circulation. 61(1):44-52, 1980.

397. Chaitman BR. Bonan R. Lepage G. Tubau JF. David PR. Dyrda I. Grondin CM. Hemodynamic evaluation of the Carpentier-Edwards porcine xenograft. Circulation. 60(5):1170-82, 1979.

398. Chaitman BR. Bourassa MG. Tubau JF. Ferguson RJ. [Quantitative analysis of exercise test results in the diagnosis of coronary disease]. [French] Union Medicale du Canada. 108(10):1236-40, 1979.

399. Tubau JF. Chaitman BR. Dupras G. Waters DD. Bourassa MG. [Diagnostic value of electrocardiography and thallium 201 scintigraphy combined with exercise following coronary disease]. [French] Union Medicale du Canada. 108(10):1210-4, 1979.

400. Weiner DA. Ryan TJ. McCabe CH. Kennedy JW. Schloss M. Tristani F. Chaitman BR. Fisher LD. Exercise stress testing. Correlations among history of angina, ST-segment response and prevalence of coronary-artery disease in the country artery surgery study (CASS). New England Journal of Medicine. 301(5):230-5, 1979.

401. Waters DD. Chaitman BR. Dupras G. Theroux P. Mizgala HF. Coronary artery spasm during exercise in patients with variant angina. Circulation. 59(3):580-5, 1979.

402. Chaitman BR. Waters DD. Bourassa MG. Tubau JF. Wagniart P. Ferguson RJ. The importance of clinical subsets in interpreting maximal treadmill exercise test results: the role of multiple-lead ECG systems. *Circulation* 59(3):560-70, 1979.

403. Bourassa MG, Chaitman BR. Aspects cliniques et evolutifs des stenoses du tronc commun de la coronaire gauche. *Inform Cardiol* 1979;2:117-119.

404. Chaitman BR. Waters DD. Corbara F. Bourassa MG. Prediction of multivessel disease after inferior myocardial infarction. *Circulation* 57(6):1085-90, 1978.

405. Sami M. Chaitman BR. Bourassa MG. Charpin D. Chabot M.Long term follow-up of aneurysmectomy for recurrent ventricular tachycardia or fibrillation. Am *Heart J* 96(3):303-8, 1978.

406. Marchandise B. Bourassa MG. Chaitman BR. Lesperance J. Angiographic evaluation of the natural history of normal coronary arteries and mild coronary atherosclerosis. *Am J Cardiol* 41(2):216-20, 1978.

407. Chaitman BR. Bourassa MG. Wagniart P. Corbara F. Ferguson RJ. Improved efficiency

of treadmill exercise testing using a multiple lead ECG system and basic hemodynamic exercise response. *Circulation* 57(1):71-9, 1978.

408. Chaitman BR. Bourassa MG. Heitz A. Campeau L. Influence of left ventricular function and other parameters on early and late mortality following coronary bypass surgery. *Canadian Journal of Surgery* 20(2):119-26, 1977.

409. Kurita A. Chaitman BR. Bourassa MG. Significance of exercise-induced junctional S-T depression in evaluation of coronary artery disease. *J Am Coll Cardiol* 40(4):492-7, 1977.

410. Chaitman BR. Grondin CM. Theroux P. Bourassa MG. Late development of left ventricular outflow tract obstruction after repair of double-outlet right ventricle. *Journal of Thoracic & Cardiovascular Surgery* 72(2):265-8, 1976.

411. Trenouth RS. Rosch J. Antonovic R. Chaitman BR. Rahimtoola SH. Ventriculography and coronary arteriography in the acutely III patient. Complications, extent of coronary arterial disease, and abnormalities of left ventricular function. *Chest* 69(5):647-54, 1976.

412. Chaitman BR. Lesperance J. Saltiel J. Bourassa MG. Clinical, angiographic, and hemodynamic findings in patients with anomalous origin of the coronary arteries. *Circulation* 53(1):122-31, 1976.

413. Chaitman BR. Bourassa MG. Lesperance J. Grondin P. Anomalous left coronary artery from pulmonary artery. An eight year angiographic follow-up after saphenous vein bypass graft. *Circulation* 51(3):552-5, 1975.

414. Chaitman BR. Bourassa MG. Lesperance J. Dominguez JL. Saltiel J. Aberrant course of the left anterior descending coronary artery associated with anomalous left circumflex origin from the pulmonary artery. *Circulation* 52(5):955-8, 1975.

415. Chaitman BR. DeMots H. Bristow JD. Rosch J. Rahimtoola SH. Objective and subjective analysis of left ventricular angiograms. *Circulation* 52(3):420-5, 1975.

416. Chaitman BR. Bristow JD. Rahimtoola SH. Left ventricular wall motion assessed by using fixed external reference systems. *Circulation* 48(5):1043-54, 1973.

417. Bonchek LI. Rahimtoola SH. Chaitman BR. Rosch J. Anderson RP. Starr A. Vein graft occlusion. Immediate and late consequences and therapeutic implications. *Circulation* 50(2 Suppl):II84-97, 1974.

418. Okies JE. Phillips SJ. Chaitman BR. Starr A. Technical consideration in multiple valve and coronary artery surgery. *Journal of Thoracic & Cardiovascular Surgery* 67(5):762-9, 1974.

419. Chaitman BR. Polyvinylpyrrolidone and activated charcoal: two nonspecific binding agents to treat drug intoxication. *McGill Med J* 1969;38:78.

420. Chaitman BR, Preshaw RM. Effects of gastrin and gastric distension on gastric and pancreatic secretion in the rat. *Can J Phys Pharm* 1967;45:558.

Book Chapters

1. Laddu AA, Alderson L, Chaitman BR. Exercise Testing. In *Cardiovascular Medicine: Coronary Artery Disease, 4rd Edition*. Willerson JT, Holmes DR ed., Springer, Ashbourne House, United Kingdom, 2015, pp. 181-203.

2. Chaitman BR. Exercise stress testing. In Braunwald's 9th Edition of Heart Disease (A Textbook of Cardiovascular Medicine). Elsevier, Bonow R, Mann DL, Zipes D, Libby P, Braunwald E ed. Philadelphia, PA, 2011, pp. 168-199.

3. Chaitman BR, Lash J. Prognostic Risk Stratification After Acute Coronary Syndromes: The Role of Noninvasive Testing. 2nd edition *Acute Coronary Syndromes. A Companion to Braunwald's Heart Disease*. Theroux P, ed. Elsevier Saunders, Philadelphia, PA, 2010, pp. 113-128.

4. The AHA Clinical Cardiac Consult 3nd Edition. Editors J.V. Nixon, Joseph Alpert, Bernard R. Chaitman, M.D., Lippincott, Williams and Wilkins, 2010.

5. Chaitman BR. Exercise stress testing. In Braunwald's 8th Edition of Heart Disease (A Textbook of Cardiovascular Medicine). W.B. Saunders Company, Libby P, Zipes D, Bonow R, Braunwald E ed. Philadelphia, PA, 2007, pp. 195-226.

6. The AHA Clinical Cardiac Consult 2nd Edition. Editors J.V. Nixon, Joseph Alpert, Bernard R. Chaitman, M.D., Lippincott, Williams and Wilkins, 2007.

7. Chaitman BR, Moinuddin M, Sano J. Exercise Testing. In *Cardiovascular Medicine, 3rd Edition*. Willerson JT, Cohn JN, Wellens HJJ and Holmes DR ed., Springer, Ashbourne House, United Kingdom, pp. 729-44, 2007.

8. Chaitman BR. Exercise stress testing. In Braunwald's 7th Edition of Heart Disease (A Textbook of Cardiovascular Medicine). W.B. Saunders Company, Libby P, Zipes D, Bonow R, Braunwald E ed. Philadelphia, PA, pp. 153-177, 2005.

9. Razek HA, Puri S, Chaitman BR. Risk stratification: Exercise testing, imaging, and cardiac catheterization. In Management of Acute Coronary Syndromes, 2nd Edition. Cannon C, ed. Humana Press, New Jersey, pp. 425-455, 2003.

10. Gussak I, Chaitman BR. The Brugada Syndrome. In Harrison's Advances in Cardiology. Braunwald E, ed. McGraw-Hill, Companies, pp. 370-77, 2003.

11. Chaitman BR. Does the angiogram still qualify as the gold standard for evaluation of noninvasive tests? In Exercise Testing: New Concepts and Guidelines for the Century. Ellestad MH, ed., Amsterdam EA, ed. Kluwer Academic Publishers, Norwell, Massachusetts, pp. 7-14, 2002.

12. The AHA Clinical Cardiac Consult. Alpert JS, ed.; Aurigemma GP, Balady GJ, Chaitman BR, Crawford MH, Epstein AE, Francis GS, Gersony WM, Harrington RA, Wenger NK, associate eds., Lippincott Williams & Wilkins, Philadelphia, PA, 2001.

13. Chaitman BR. Exercise stress testing. In Braunwald's 6th Edition of Heart Disease (A Textbood of Cardiovascular Medicine). W.B. Saunders Company, Braunwald E, Libby P, Zipes DP ed. Philadelphia, PA, pp. 129-159, 2001.

14. Puri S, Chaitman BR. Risk stratification: Exercise testing, imaging, and cardiac catheterization. In Management of Acute Coronary Syndromes. Cannon C, Braunwald E (eds). Humana Press, New Jersey, pp. 383-405, 1998.

15. Younis LT, Chaitman BR. Noninvasive diagnosis of saphenous vein bypass graft disease. In Management of Saphenous Vein Bypass Grafting Disease. Bates ER, Holmes DR Jr (eds.). Marcel Dekker, Inc., New York, pp. 113-134, 1998.

16. Chaitman BR. Care after myocardial infarction. In Conn's Current Therapy 50th Anniversary Edition 1998. Rakel RE (ed.). W.B. Saunders, Philadelphia, Pennsylvania pp. 324-327, 1998.

17. Chaitman BR, Zhou SH, Stocke K, Gussak I, Miller M, Rautaharju PW. Coding of serial EKC changes using an adaption of the NOVACODE for Q-wave myocardial infarction in a large multicenter clinical trial: The Bypass

Angioplasty Revascularization Investigation experience. In Electrocardiology '97. Standards for Core ECG Laboratories. Bacharova L, Macfarlane PW (eds). World Scientific Publishing Co. Pte. Ltd., Singapore pp. 365-368.

18. Zhou SH, Chaitman BR, Rautaharju PM, Gussak I, Stocke K. Gender differences in ECG Q wave serial changes. In Electrocardiology '96. From the Cell to the Body Surface. Liebman J (ed). World Scientific Publishing Co. Pte. Ltd., Singapore pp. 541-544.

19. Gussak I, Bjerregaard P, Greenwalt T, Chaitman BR. Electrophysiological pecularities of the electrocardiographic J wave: from hypothermia to Brugada syndrome. In Electrocardiology '96. From the Cell to the Body Surface. Liebman J (ed). World Scientific Publishing Co. Pte. Ltd., Singapore pp. 261-264.

20. Feit F, Chaitman BR. Management of the elderly patient with acute myocardial infarction. In Acute Coronary Care, 2nd edition. Califf RM, Mark DB, Wagner GS (eds.). Mosby Year Book, St. Louis, MO pp. 697-706, 1995.

21. Chaitman BR. Exercise Electrocardiographic stress testing. In 5th Edition of Atlas of Heart Diseases, Chronic Ischemic Heart Disease (A Textbook of Cardiovascular Medicine). Beller GA, Braunwald E (eds.). Mosby-Year Book, Inc. St. Louis, MO Chapter 2, pp. 2.1-2.30, 1995.

22. Chaitman BR, Miller DD. Nuclear imaging in the assessment of acquired heart disease. In the 6th Edition of Glenn's Thoracic and Cardiovascular Surgery. Baue AE, Geha AS, Hammond GL, Laks H, Naunheim KS (eds.). Appleton and Lange, E. Norwalk, pp. 1735-1755, 1995.

23. Chaitman B. Exercise stress testing. In Braunwald's 5th edition of Heart Disease (A Textbook of Cardiovascular Medicine). W.B. Saunders Company, Philadelphia, PA. Chapter 5, pp. 153-176, 1997.

24. Chaitman BR. Exercise ECG testing. A continuing education series on Myocardial Perfusion Imaging (Part 1): Diagnosis of ischemic heart disease (1). Iskandrian AS (ed.), Am J Cardiol, October 1993 pp. 3-9.

25. Chaitman BR. Exercise stress testing. In Braunwald's 4th edition of Heart Disease (A Textbook of Cardiovascular Medicine). W. B. Saunders Company, Philadelphia, PA. pp. 161-179, 1992.

26. Chaitman BR, Fletcher JW. Nuclear imaging in the assessment of acquired heart disease. In 5th edition, Volume II, Glenn's Thoracic and Cardiovascular Surgery. Baue AE, Geha AS, Hammond GL, Laks H, Naunheim KS (eds.), Appleton and Lange, E. Norwalk, CT. pp. 1487-1504, 1991.

27. Buckingham TA, Chaitman BR. Stress testing. In Progress in Cardiology. Zipes DP, Rowland DJ (eds.). Lea & Febiger, Inc., Philadelphia, PA. pp. 289-303, 1988.

28. Chaitman BR. Stress testing after acute myocardial infarction. In Long Term Management of Patients after Myocardial Infarction. Kappagoda CT, Greenwood PV (eds.), Martinus Nijhoff Publishing, pp. 97-111, 1988.

29. Bourassa MG, Chaitman BR, Lam J, Hung J. Diagnostic procedures of ischemic heart disease in women. In Coronary Heart Disease in Women. Eaker ED, Packard B, Wenger NK, Clarkson TB, Tyroler HA (eds.), Haymarket Doyma, Inc., New York, NY. pp. 222-228, 1987.

30. Chaitman BR, Buckingham T. Evaluation of the patient with angina pectoris. In Angina Pectoris Therapy, A Comprehensive Guide for the Clinician. Weiner DA, Frishman W (eds.), Marcel Dikker, Inc., New York, NY. pp. 9-36, 1986.

31. Chaitman BR, Goodgold H. Clinical selection criteria and role of noninvasive testing for percutaneous transluminal coronary angioplasty. In Coronary Angioplasty. Ischinger T (ed.), Springer-Verlag Publishers. pp. 15-28, 1986.

32. Buckingham T, Kennedy HL, Chaitman BR. Use of surface His bundle recordings and late after-potentials in the diagnosis and management of conduction and arrhythmic disturbances. In Practical Cardiology, Arrhythmia Clinic. pp. 13-19, 1985.

33. Chaitman BR, Waters DD. Exercise ECG in patients with coronary artery spasm. In Exercise Electrocardiography Practical Approach. Chung EK (ed.), Williams and Wilkins Co., 2nd edition. pp. 91-103, 1983.

34. Chaitman BR, Brevers G, Wagniart P, Ferguson RJ, Pasternac. Comparison of nifedipine and propranolol on exercise tolerance in chronic stable angina pectoris. In First Canadian Nifedipine Symposium. Theroux P, Waters D (eds.). Exerpta Medica, Inc. pp. 145-157, 1983.

35. Davis KB, Kennedy JW, Berger RL, Kaiser GC, Killip T, Alderman EL, Austen G, Bourassa MG, Brooks H, Chaitman BR and participating CASS medical centers. Operative mortality in the CASS registry. In Coronary Bypass Surgery. Hammersmeister K (ed.)., Praeger Scientific, Inc. pp. 99-128, 1983.

36. Davis KB, Chaitman BR, Killip T, Alderman EL, Austen G, Berger RL, Bourassa MG and participating CASS medical centers. Effect of coronary bypass surgery on operative mortality and survival patterns in subsets of patients with left main coronary artery disease. In Coronary Bypass Surgery. Hammersmeister K (ed.)., Praeger Scientific, Inc. pp. 129-152, 1983.

37. Betriu A, Chaitman BR, Almazan A, Guiteras P, Pelletier G. Preoperative determinants of return to sinus rhythm after valve replacement. In Cardiac Bioprostheses II. Cohn LH, Gallucci V, (eds.)., Yorke Medical Books, pp. 184-192.

38. Fisher LD, Alderman ED, Mock MB, Chaitman BR, Ringqvist I, Ryan TJ, Levine F, Kaiser GC, Schloss M, Killip T, Oberman A, Litwin P. Statistical considerations in evaluating treatment of advanced congestive heart failure. In Congestive Heart Failure. Braunwald E, Mock MB, Watson JT (eds.), Grune and Stratton, Inc. pp. 357-366, 1982.

39. Pelletier C, Chaitman BR, Bonan R, Dyrda I. Hemodynamic evaluation of the Carpentier-Edwards standard and improved annulus bioprostheses. In Cardiac Bioprostheses II. Cohn LN, Gallucci V (eds.), Yorke Medical Books, Inc. pp. 91-104.

40. Taylor AW, Ferguson RJ, Petitclerc R, Ricci J, Fournier M, Montpetit RR, Chaitman BR. Cardiac and skeletal muscle adaption to continuous and short interval training in adolescent boys. In the 4th International Symposium on Biochemistry of Exercise. Poortmans J (ed.), volume 11B, pp. 283-289, 1981.

41. Chaitman BR, Ferguson RJ. Stress testing, exercise physiology and cardiac rehablitation. In Current Cardiology, vol. 2. Rosen K (ed.)., Houghton Mifflin Professional Publishers, pp. 71-111, 1980.

42. Chaitman BR, Bonan R, Lepage G, Tubau JF, David PR, Dyrda I, Grondon CM. Performance characteristics of the Carpentier-Edwards xenograft. In Proceedings of the World Symposium: Munich. Sebening F, Kolovekom WP, Meisner H, Struck E (eds.), pp. 221-233, 1979.

43. Wagniart P, Chaitman BR, Krantz D, Peronnet F, Ferguson RJ, Bourassa MG. Relation du produit frequence-pression a l'exercise et de l'etendue des obstructions coronaires. Groupe de travail sur les Epreuves d'Effort de la Societe Europeanne de Cardiologie, Expansion Scientifique Francaise, Paris. Broustet JP, Bricaud H, Denolin H (eds.), 1978.

Reviews

1. Chaitman BR. Efficacy and safety of a metabolic modulator drug in chronic stable angina: review of evidence from clinical trials. J Cardiovasc Pharmacology and Therapeutics 2004;9;S47-S64.

2. Chaitman BR. A review of the GUARDIAN trial results: Clinical impressions, and the significance of elevated perioperative CK-MB on 6-month survival. J Card Surg 18:13-20, 2003.

3. Chaitman BR, Bitar SR. Is ST segment elevation non-Q-wave myocardial infarction after thrombolytic therapy a new clinical entity that Requires an invasive management strategy? J Am Coll Cardiol 2001;37:26-29.

4. Chaitman BR. Section Editor: Clinical trials: Editorial Overview. Current Opinion in Cardiology 2000;15:273-308.

5. Chaitman BR. Exercise and the heart, 4th Edition. Froelicher V, Myers JN (eds). WB Saunders Co., Philadelphia 2000.

6. Osada N, Chaitman B. Mortality predictors using cardiopulmonary exercise testing in patients with compensated heart failure. J Am Coll Cardiol (Letter to the Editor) 1999.

7. Jacobs AK, Kelsey SF, Brooks MM, Faxon DF, Chaitman BR, Bittner V, Mock MB, Weiner BH, Dean L, Winston C, Drew L, Sopko G. Better outcome for women as compared to men undergoing coronary revascularization: a report from the Bypass Angioplasty Revascularization Investigation (BARI). Circulation (response to Letter to the Editor) 1999.

8. Chaitman BR, Miller DD. Perioperative cardiac evaluation for non-cardiac surgery noninvasive cardiac testing. Prog CV Dis 1998;40(5):405-418.

9. Chaitman BR. Cardiac intensive care. (book review). Brown DL (ed), W.B. Saunders Co., Philadelphia. 1998;pp1-861. Clinical Cardiology 1998;21:790.

10. Craig WR, Chaitman BR. Management of stable angina pectoris. Cardiology Special Edition 1998;4(1):39-42.

11. Wiens RD. Chaitman BR. An alternate limb lead system for electrocardiograms in emergency patients [letter]. American Journal of Emergency Medicine. 15(1):94-5, 1997.

12. Chaitman BR. What has happened to risk stratification with noninvasive testing? ACC Current J Review 1996;Sept./Oct.:33-35.

13. Younis LT. Miller DD. Chaitman BR. Preoperative strategies to assess cardiac risk before noncardiac surgery. [Review] Clinical Cardiology. 18(8):447-54, 1995.

14. Gussak I. Bjerregaard P. Egan TM. Chaitman BR. ECG phenomenon called the J wave. History, pathophysiology, and clinical significance. [Review] Journal of Electrocardiology. 28(1):49-58, 1995.

15. Chaitman BR. Jaffe AS. What is the true periprocedure myocardial infarction rate? Does anyone know for sure? The need for clarification [letter]. Circulation. 91(5):1609-10, 1995.

16. Chaitman BR. Early risk stratification after acute myocardial infarction: impact of newer treatment strategies. Japanese Circulation Control 1994;15: 394-403.

17. Younis LT. Chaitman BR. The prognostic value of exercise testing. [Review] Cardiology Clinics. 11(2):229-40, 1993.

18. Weintraub NL. Chaitman BR. Newer concepts in the medical management of patients with congestive heart failure. Review Clinical Cardiology. 16(5):380-90, 1993.

19. Al-Joundi B, Chaitman BR. The use of electrocardiography as a diagnostic and prognostic tool in coronary artery disease. Current Opinion in Cardiology 1992;7:587-94.

20. Weiner DA. Chaitman BR. Role of exercise testing in relationship to coronary artery bypass surgery and percutaneous transluminal coronary angioplasty. [Review] Cardiology. 73(4-5):242-58, 1986.

21. Redd RM, Chaitman BR. Oral diltiazem and supraventricular arrhythmias. Chest 1985;87:561.

22. Lam J, Chaitman BR. Diagnostic choice of exercise ECG lead systems in the routine clinical assessment of patients with chest pain. Practical Cardiology 1983;9:71-83.

23. Bernard P. Chaitman BR. Pelletier CH. Pham-Huy H. Laurier J. [Present situation of interpreting computerized electrocardiography]. [French] Union Medicale du Canada. 111(2):101-6, 1982.

24. Chaitman BR. Waters DD. Theroux P. Hanson JS. S-T segment elevation and coronary spasm in response to exercise. [Review] American Journal of Cardiology. 47(6):1350-8, 1981.

25. Chaitman BR. Hanson JS. Comparative sensitivity and specificity of exercise electrocardiographic lead systems. [Review] American Journal of Cardiology. 47(6):1335-49, 1981.

26. Ferguson RJ. Bourassa MG. Cote P. Chaitman BR. [Cardiovascular effects of exercise and physical training in coronary disease]. [Review] [French] Union Medicale du Canada. 108(10):1187-94, 1979.

27. Chaitman BR. Priorities in risk stratification following myocardial infarction. A modern medicine interview by E. Leibovitch. Modern Medicine 1991;59:56-67.

28. Chaitman BR. Who needs an exercise stress test? Contemporary Internal Medicine 1990;January:61-66.

29. Kong BA, Chaitman BR. Stress testing after coronary angioplasty. Cardio 1990:89-95.

30. Wittry MD. Thornton TA. Chaitman BR. Safe use of thrombolysis in the elderly. Geriatrics. 44(11):28-30,
33-6, 1989.

31. Ferst JA. Chaitman BR. The electrocardiogram and the athlete. [Review] Sports Medicine. 1(5):390-403, 1984.

32. Chaitman BR. The treatment of asthma in children. McGill Med J 1969;38:37.

Abstracts

1. Sidhu M, Alexander K, Huang Z, Mathew R, O'Brien S, Foleg J, Kretov E, Briguori C, Mazurek T, Roik M, Bockeria O, Shutov E, Govindan S, Pellikka P, Lyubarova R, Goodman S, Orso F, Reynolds H, Chaitman B, Hochman J, Maron D, Bangalore S. Causes of cardiovascular and non-cardiovascular mortality in the Ischemia – CKD Trial. Accepted for presentation 2021 Annual American College of Cardiology Scientific Sessions, Atlanta, GA May 15-17, 2021.

2. Chaitman B, Kunichoff D, Alexander K, Pracon R, Bainey K, Mathew A, Archarya A, Lopes R, Fleg J, Sidhu M, Rockhold F, Maron D, Hochman J, Bangalore S. Myocardial infarction rates by definition, type and treatment in the Ischemia- CKD trial. Accepted for presentation 2021 Annual American College of Cardiology Scientific Sessions, Atlanta, GA May 15-17, 2021.

3. Newman J, Anthopolos R, Mancini J, Bangalore S, Reynolds H, Senior R, Peteiro J, Bhargava B, Garg P, Escobedo J, Doerr R, Mazurek T, Ooman A, Gonzalez-Juanatey J, Gajos G, Sharir T, Keltai M, Maggioni A, Stone G, Berger J, Rosenberg Y, Boden W, Chaitman B, Hochman J, Maron D. Management and outcomes of patients with diabetes mellitus (DM) and stable ischemic heart disease (SIHD): Pooled data from the Ischemia and Ischemia – CKD trials. Accepted for presentation 2021 Annual American College of Cardiology Scientific Sessions, Atlanta, GA May 15-17, 2021.

4. Sidhu M, Alexander KP, Chaitman BR, O'Brien SM, Huang Z, Stone GW, Newman JD, Boden WE, Maggioni AP, Steg PG, Ferguson TB, Demkow M, Peterio J, Singh Wander G, deBelder MA, Szwed H, Doerr R, Alexanderson E, Polanczyk C, Henriksen P, Conway D, Miro V, Sharir T, Rosenberg YD, Bangalore S, Reynolds HR, Hochman JS Maron JW. Causes of cardiovascular and non-cardiovascular mortality in the Ischemia trial. Circulation 2020;142(3):A13030.

5. Senior R, Reynolds HR, Min J, Berman DS, Picard M, Chaitman BR, Shaw L, Page CB, Govindan S, Lopez-Sendon J, Peteiro, Wander GS, Drozdz J, Marin-Neto J, Selvanayagam JB, Newman JD, Thuaire C, Jang J, Bangalore S, Stone GW, O'Brien S, Fleg J, Boden WE, Maron DJ, Hochman JS. Prediction of left main disease using clinical and stress test parameters. J Am Coll Cardiol 2020 75(11 Suppl 1) 52; DOI:10.1016/S0735-1097(20)30679-3.

6. Reynolds HR, Shaw L, Min J, Berman D, Chaitman B, Picard M, Kwong R, O'Brien S, Page C, Huang Z, Nath R, Dwivedi S, Stone P, Held C, Keltai M, Bangalore S, Harrington R, Newman J, Maron D, Hochman J. Relationshipos of ischemia severity and coronary artery disease extent with clinical outcomes in the Ischemia Trial. J Am Coll Cardiol 2020 75(11 Suppl 1) 52; DOI:10.1016/S0735-1097(20)30648-3.

7. Reynolds HR, Shaw LJ, Min J, Mark D, Spertus JA, Berman DX, Chaitman B, Picard M, Kwong RY, Page CB, Phillips L, alexander K, Senior R, Chen J, Szwed H, Doerr R, Bainey K, Ramos R, Ong P, Bangalore S, Boden WE, O'Brien S, Maron D, Hochman JS. Coronary anatomy, ischemia and angina: Associations at baseline in the Ischemic Trial. J Am Coll Cardiol 2020 75(11 Suppl 1) 52; DOI:10.1016/S0735-1097(20)30679-3.

8. Chaitman B, Alexander K, Cyr D, Berger J, Reynolds H, Bangalore S, Boden W, Lopes R, Demkow M, Perna G, Riezebos R, McFalls E, Gosselin G, O'Brien S, Rockhold F, Waters D, Thygesen K, White H, Stone G, Maron D, Hochman J. Variation in myocardial infarction rates by type and definition in the Ischemia Trial. J Am Coll Cardiol 2020 75(11 Suppl 1) 52; DOI:10.1016/S0735-1097(20)30679-3.

9. Reynolds HR, Shaw LJ, Chaitman B, Berman DS, Picard M, Merz DN, Cyr D, Steg P, Lopes R, Lopez-Sendon J, Held C, Szwed H, Senior R, Gosselin G, Nair R, Elghamaz A, Bockeria O,

Chen J, Chernyavaskiy A, Bhargava B, Newman J, Hinic S, Loboz-Grudzien K, Hoye A, Hochman J. Sex differences in stress test and CCTA findings and symptoms in the randomized Ischemia Trial. J Am Coll Cardiol 2020 75(11 Suppl 1) 52; DOI:10.1016/S0735-1097(20)30657-4.

10. Everett BM, Brooks MM, Vlachos HEA, Chaitman BR, Frye RL, Bhatt D. Novel markers of residual risk in type 2 diabetes and stable ischemic heart disease: Insights from the BARI 2D Trial. Accepted for poster presentation at the American Heart Association Scientific Sessions, November 12-16, 2016. Circulation 2016;134:A12577.

11. Belov D, Sidhu MS, Hartigan PM, Maron DJ, Mancini GBJ, Spertus JA, Teo K, Sedlis S, Chaitman BR, Weintraub WS, Brown D, Boden WE. Effect of percutaneous revascularization added to optimal medical therapy on clinical outcomes in patients with prior myocardial infarction, heart failure, or reduced systolic function: A post hoc analysis of the COURAGE trial. Accepted for poster presentation at the American College of Cardiology Scientific Sessions Meeting, April 2-4, 2016. *J Am Coll Cardiol* 2016;67:2147.

12. Sidhu MS, Lavelle MP, Hartigan PM, Maron DJ, Mancini GBJ, Spertus JA, Teo KK, Sedlis S, Chaitman BR, Weintraub WS, Boden WE. Association between blood pressure variability and long term survival in patients with stable ischemic heart disease: A post-hoc analysis of the COURAGE Trial. Accepted for poster presentation at the American College of Cardiology Scientific Sessions Meeting, April 2-4, 2016. *J Am Coll Cardiol* 2016;67: 2157.

13. Everett BM, Brooks M, Vlachos H, Chaitman BR, Frye RL, Bhatt DL. Sex differences in cardiac troponin and the risk of death or major cardiovascular events in men and women with diabetes and coronary artery disease. Accepted for oral presentation at the American Heart Association Scientific Sessions Meeting, November 7-11, 2015, Orlando, FL. *Circulation* 2015;132: A11930.

14. Mancini GBJ, Farkouh ME, Chaitman BR, Boden WE, Frye RL, Hartigan PM, Vlachos H, Siami FS, Sidhu MS, Bittner VA, Fuster V, Brooks MM. Comparative assessment of medical therapy, PCI, or CABG on clinical outcomes in diabetic patients with stable CAD according to coronary angiography and left ventricular function: Patient-level Meta-analysis of the BARI-2D, COURAGE, and FREEDOM Trials. American Heart Association Scientific Sessions, Orlando, FL. Accepted for oral presentation at the American Heart Association Scientific Sessions Meeting, November 7-11, 2015, Orlando, FL. *Circulation* 2015;132: A10383.

15. Carson JL, Sieber F, Hoover DR, Noveck H, Chaitman BR, Beaupre L, Maculay W, Rhoads G, Fleisher L, Cook DR, Sanders D, Zakriya K, Paris B, Zagorin A, Magaziner J. A randomized clinical trial of liberal versus restrictive transfusion strategy evaluating long term survival and cause of death: Results from the FOCUS Trial. Accepted for presentation at the 56th American Society of Hematology (ASH) Annual Meeting and Exposition, December 6-9, 2014. *Blood* 2014; 124(21):757.

16. Everett BM, Brooks M, Vlachos H, Chaitman B, Frye R, Bhatt D. High Sensitivity Cardiac Troponin T and B-Type Natriuretic Peptide Predict Death and Major Cardiovascular Events but Not Benefit From Immediate Revascularization in Type 2 Diabetes and Stable Ischemic Heart Disease: A BARI 2D Substudy. Accepted for oral presentation at the American Heart Association Scientific Sessions Meeting, November 15-19, 2014, Chicago, IL. *Circulation* 2014; 130: A12675

17. Everett BM, Brooks M, Vlachos H, Chaitman B, Frye R, Bhatt D. Effects of glucose control and coronary revascularization strategies on cardiac troponin and natriuretic peptide levels in patients with type 2 diabetes and stable ischemic heart disease: a BARI-2D substudy. Accepted

for presentation at the American Heart Association Scientific Sessions. *Circulation* 2014; 130: A15078.

18. Brooks MM, Chaitman BR, Singh M, Vlachos H, Steiner G, Krishnaswami A, Orchard TJ, Feit F, Rihal C, Marroquin O. Predictors of cardiovascular and noncardiovascular death: from the clinic to the lab. Accepted for presentation at the American Heart Association Scientific Sessions. *Circulation* 2014; 130: A12072

16. Archarjee S, Figueredo V, Hartigan P, Teo K, Maron D, Sedlis S, Kostuk W, Spertus J, Dada M, Chaitman B, Mancini GBJ, Weintraub W. Achieved blood pressure targets and cardiovascular outcomes in stable ischemic heart diease: a post hoc analysis from the COURAGE trial. Accepted for presentation at the American Heart Association Scientific Sessions. *Circulation* 2014; 130:A20094.

17. Archarjee S, Boden W, Hartigan P, Teo K, Maron D, Sedlis S, Kostuk W, Spertus J, Dada M, Chaitman B, Mancini GBJ, Weintraub W. Burden of coronary atherosclerosis and cardiovascular events in men and women with stable ischemic heart disease. Accepted for presentation at the American Heart Association Scientific Sessions. *Circulation* 2014; 130:A19993.

18. Arnold SV, McGuire DK, Spertus JA, Li Y, Yue P, Inzucchi SE, Belardinelli L, Chaitman BR, Kosiborod M. Glucose-Lowering Medications and Angina Burden in Patients With Stable Coronary Disease. Results from the TERISA Trial. Accepted for presentation at the American Heart Association Scientific Session. *Circulation* 2014;130:A11383.

19. Acharjee S, Boden WE, Hartigan PM, Teo KK, Maron DJ, Sedlis SP, Kostuk W, Spertus JA, Dada M, Chaitman BR, Mancini GBJ, Weintraub WS. Impact of high-density lipoprotein cholesterol on revascularization procedures in patients with stable ischemic heart disease: A post-hoc analysis from the COURAGE trial. Selected as a Young Investigator Award for the National Lipid Association (NLA) Scientific Sessions, May 1-4, 2014, Orlando, FL.

20. Pandala S, Sidhu M, Hartigan P, Teo K, Spertus J, Maron D, Mancini GBJ, Sedlis S, Chaitman B, Heller G, Weintraub W, Boden W. Baseline Exercise Capacity and Cardiovascular Outcomes in Patients with Stable ischemic Heart Disease: A Post Hoc Analysis of the COURAGE Trial. Accepted for presentation at the American College of Cardiology Meeting, March 30, 2014, Washington, DC. *J Am Coll Cardiol* 2014, 63:A1574.

21. Padala S, Sidhu M, Hartigan P, Teo K, Chaitman B, Heller G, Weintraub W, Boden W. Baseline Exercise Capacity and Improvement in Quality of Life in Patients with Stable ischemic Heart Disease: A Post Hoc Analysis of the COURAGE Trial. Accepted for presentation at the American College of Cardiology Meeting, March 30, 2014, Washington, DC. *J Am Coll Cardiol* 2014, 63:A1641.

22. Bagai A, Chaitman BR, Gosselin G, Shah BN, Diaz A, Humen D, Banerjee S, Perna GP, Schuchlenz H, Cheema AN, Wu A, Kronenberg MW, Aronow HD, Miller TD, El-Hajjar M, Druz R, Pracon R, Newby LK, Alexander K, Goodman S, Bangalore S, Maron DJ, Hochman JS, Mahaffey KW. Substantial variability between laboratories in troponin decision level for diagnosis of myocardial infarction assay 99th percentile: findings from the International Study of Comparative Health Effectiveness with Medical and Invasive Approaches (ISCHEMIA) Trial. Accepted for presentation at the American College of Cardiology Meeting, March 30, 2014, Washington, DC. *J Am Coll Cardiol* 2014;63:A1878.

23. Arnold SV, McGuire DK, Spertus JA, Li Y, Yue P, Ben-Yehuda O, Belardinelli L, Katz A, Jones PG, Olmsted A, Chaitman BR, Kosiborod M. Effectiveness of ranolazine in patients with type 2 diabetes mellitus and chronic stable angina according to baseline hemoglobin A1c.

Accepted as presentation at the American Heart Association Scientific Sessions, November 16-19, 2013, Dallas, TX. *Circulation* 2013;128:A14751.

24. Arnold SV, Kosiborod M, McGuire DK, Li Y, Yue P, Ben-Yehuda O, Belardinelli L, Katz A, Jones PG, Olmsted A, Chaitman BR, Spertus JA. Effectives of ranolazine on disease-specific health status and quality of life among patients with diabetes and stable angina: Results from the TERISA randomized trial. Accepted as presentation at the American Heart Association Scientific Sessions, November 16-19, 2013, Dallas, TX. *Circulation* 2013;128:A17574.

25. Acharjee S, Sidhu MS, Hartigan PM, Teo KK, Maron DJ, Sedlis SP, Mancini J, Chaitman BR, Spertus JA, Weintraub WS, Boden WE. Sex-based comparison of angina severity, extent of inducible ischemia, and burden of angiographic coronary disease: A post hoc analysis of the COURAGE trial. Accepted as presentation at the American Heart Association Scientific Sessions, November 16-19, 2013, Dallas, TX. *Circulation* 2013;128:A18129.

26. Kosiborod M, Arnold SV, Spertus JA, McGuire DK, Li Y, Katz A, Yue P, Jones PG, Olmsted A, Ben-Yehuda O, Belardinelli L, Chaitman BR. Evaluation of ranolazine in patients with type II diabetes mellitus and chronic stable angina: Results from the Type II Diabetes Evaluation of Ranolazine in Subjects with Chronic Stable Angina (TERISA) randomized clinical trial. Accepted for Late-Breaking session at the American College of Cardiology Meeting, March 10, 2013, San Francisco, CA. *J Am Coll Cardiol* 2013;61(20):2038-2045.

27. Bindra A, Teo K, Sidhu M, Hartigan P, Maron D, Kostuk W, Sedlis S, Mancini GBJ, Bates E, Scirica B, Spertus J, Weintraub W, Chaitman B, Boden W. Prevalence and clinical significance of recurrent and unremitting angina with percutaneous intervention versus optimal medical therapy in patients with stable ischemic heart disease: a post hoc analysis of the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation Trial (COURAGE). Accepted for poster presentation at the American College of Cardiology Meeting, March 11, 2013, San Francisco, CA. *J Am Coll Cardiol* 2013;61(10_S):. doi:10.1016/S0735-1097(13)61205-X.

28. Schwartz GG, Olsson AG, Abt M, Ballantyne CM, Barter P, Chaitman BR, Holme IM, Kallend D, Leiter LA, Leitersdorf E, McMurray JJ, Mundl H, Nicholls S, Shah PK, Tardif J, Wright RS. Effects of the cholesteryl ester transfer protein inhibitor Dalcetrapib in patients with recent acute coronary syndrome. Accepted for Late Breaking Clinical Trials: Novel Treatments for Managing Lipid Disorders and presented at the American Heart Association's Scientific Sessions, November 5, 2012. *Circulation* 2012;126:2776-2799.

29. Harrison RW, White K, Domanski MJ, Brener SJ, Smith PK, Hillis GS, Engoren M, Alexander JH, Levy JH, Chaitman BR, Mack MJ, Farkouh, Mahaffey KW. Frequency and prognostic importance of troponin and CK-MB elevations following coronary artery bypass grafting: An analysis from PRIMO I and PRIMO II. Accepted for oral presentation at the American Heart Association's Scientific Sessions, November 5, 2012. *Circulation* 2012;126:A17725.

30. Dada MS, Teo KK, Hartigan PM, Bates ER, Sedlis SP, Mancini G, Maron DJ, Spertus JA, Kostuk WJ, Gosselin G, Tanguay J, Sidhu MS, Berman DS, Shaw LJ, Weintraub WS, Chaitman BR, Boden WE. Long-term clinical outcomes of patients with Type 4a myocardial infarction following elective PCI for stable ischemic heart disease (SIHD): Post hoc analysis of the COURAGE Trial. Accepted for oral presentation at the American Heart Association's Scientific Sessions, November 6, 2012. *Circulation* 2012;126:A16865.

31. Scirica BM, Belardinelli L, Chaitman BR, Waks JW, Volo SC, Karwatowska-Prokopczuk E, Cheng ML, Murphy SA, Morrow DA. Effect of

ranolazine on atrial fibrillation among patients with non-ST elevation acute coronary syndromes (NSTEACS) – observations from the MERLIN-TIMI 36 trial. Accepted for presentation at the American Heart Association's Scientific Sessions. *Circulation* 2011;124:A13798.

32. Acharjee S, Boden WE, Hartigan PM, Teo KK, Maron DJ, Sedlis SP, Chaitman BR, Spertus JA, Dada M, Mancini GBJ, O'Rourke RA, Weintraub WS. High-density lipoprotein (HDL) cholesterol is associated with residual risk of cardiovascular events in patients with stable ischemic heart disease despite optimal levels of low-density lipoprotein (LDL) cholesterol: A post hoc analysis from the COURAGE trial. Accepted for poster presentation at the American College of Cardiology's Scientific Sessions. *J Am Coll Cardiol* 2011;57:E1046.

33. Boden WE, Hartigan PM, Teo KK, Maron DJ, Sedlis SP, Bates ER, Chaitman BR, Spertus JA, Kostuk WJ, Dada MR, Gosselin G, Berman DS, Shaw L, Knudtson M, Blaustein AS, Booth DC, Mancini GBJ, O'Rourke RA, Weintraub WS. A new risk prediction tool to assess long-term prognosis in patients with stable ischemic heart disease (SIHD): The "COURAGE Risk Score." Accepted for oral presentation at the American College of Cardiology's Scientific Sessions. *J Am Coll Cardiol* 2011; 57:E900.

34. Chaitman BR, Hardison RM, Marroquin O, Brooks MM, Adler DS, Feit F, Frye RL. Multifactorial risk of cardiac mortality and myocardial infarction in type 2 diabetes mellitus. A BARI 2D substudy. Accepted for poster presentation at the American Heart Association's Scientific Sessions. *Circulation* 2010;122:A10145.

35. Shaw LJ, Cerqueira M, Brooks MM, Sansing VV, Beller GA, Pop-Busui R, Taillefer R, Chaitman BR, Gibbons RJ, Iskandrian AE. Comparison of 1-year myocardial perfusion pattern by randomized treatment in patients with diabetes and coronary artery isease and relation to clinical outcomes: Results from the BARI 2D trial. Accepted for oral presentation at the American Heart Association's Scientific Sessions. *Circulation* 2010;122:A12697.

36. Nesto R, Brooks M, Hardison R, Sako E, Rogers W, Feit F, Davidson C, Chaitman B, Gersh B, Krone R, Garber A, King S, Frye R. Angiographic criteria determine effectiveness of CABG among patients with diabetes and stable ischemic heart diseae: results from the Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI 2D) Trial. Accepted for oral presentation at the American Heart Association's Scientific Sessions. *Circulation* 2010;122:A18327.

37. Schwartz G, Chaitman BR, et al. Effect of high-dose atorvastatin on risk of atrial fibrillation in patients with prior stroke or transient ischemic attack: Analysis of the Stroke Prevention by Aggressive Reduction in Cholesterol Levels (SPARCL) trial. Accepted for oral presentation to the American Heart Association's Scientific Sessions. *Circulation* 2010;122:A10897.

38. Chaitman BR, Ho AP, Behm MO, Rowe JF, Palcza JS, Laethem T, Heirman I, Panebianco DL, Moiseev VS, Martsevich SY, Free AL, Bittar N, Chrysant SG, Ho TW, Chodakewitz JA, Murphy MG, Blanchard RL. The Calcitonin gene-related peptide receptor antagonist telcagepant does not reduce exercise tolerance in patients with exercise induced myocardial ischemia. Accepted for poster presentation at the American College of Cardiology Meetings, March 2010. *J Am Coll Cardiol* 2010;55:100A.E939.

39. Shaw LJ, Berman DS, Maron DJ, Hachamovitch R, Hartigan PM, Min JK, Sedlis SP, Dada M, Mancini GBJ, O'Rourke RA, Spertus JA, Chaitman BR, Bates ER, Teo KK, Boden WE, Weintraub WS. Impact of pretreatment on therapeutic risk reduction and lont-term prognosis in patients with stable angina: Results from the COURAGE Trial. Accepted for presentation at the American

College of Cardiology Meetings, March 2010. *J Am Coll Cardiol* 2010;55:98A.E925.

40. Chaitman BR, Adler D, Gebhart S, Grogan M, Hardison RM, Ocampo S, Ramires JA, Schneider D, Sopko G. Prompt coronary revascularization reduces non-fatal myocardial infarction in patients with type II diabetes and more extensive vascular disease: results from the BARI2D. Accepted for Late-Breaking session at the American Heart Association's Scientific Sessions, November 17, 2009, Orlando, Florida. *Circulation* 2009;120:2159.

41. Carson JL, Terrin ML, Chaitman B, Magaziner J, Sanders D. Impact of transfusion triggers on postoperative myocardial infarction or death. Accepted for Late-Breaking session at the American Heart Association's Scientific Sessions, November 16, 2009, Orlando, Florida. *Circulation* 2009;120:2155.

42. Boden WE, Teo KK, Hartigan PM, Maron DJ, Mancini GBJ, Bates ER, Chaitman BR, Spertus J, Kostuk WJ, Dada MR, Gupta V, Sedlis SP, Berman DS, Shaw LJ, O'Rourke RA, Weintraub WS. Comparison of optimal medical therapy with or without PCI on cardiovascular endpoints in patients with silent myocardial ischemia: Post hoc analysis from the COURAGE trial. *J Am Coll Cardiol* 2009;53 (Suppl. A), A352.

43. Chaitman BR, Hartigan PM, Booth DC, KK Teo, Mancini J, Kostuk WJ, Spertus JA, Maron DJ, Dada M, O'Rourke RA, Weintraub WS, Boden WE, Berman DS, Shaw LJ, for the COURAGE Investigators. Do different healthcare systems impact major outcomes in stable coronary disease patients enrolled in COURAGE? Accepted for poster presentation at the National Scientific Sessions of the American College of Cardiology meetings. *J Am Coll Cardiol* 2008;51 (Suppl. A) A222.

44. Mancini GBJ, Hartigan PM, Maron DJ, Shaw L, Berman D, Chaitman B, Bates ER, Kostuk W, Knudtsen M, Dada M, Teo KK, O'Rourke RA, Boden WE. Relation of angiographic patterns and ejection fraction to clinical outcomes in the COURAGE trial. Accepted for poster presentation at the National Scientific Sessions of the American College of Cardiology meetings. *J Am Coll Cardiol* 2008;51 (Suppl. A) A244.

45. Boden WE, Jacobs AK, Teo KK, Hartigan PM, Maron DJ, Kostuk WJ, Chaitman BR, Mancini J, Dada M, Bates E, Booth DC, Weintraub WS, O'Rourke RA. Clinical outcomes in women with stable coronary artery disease randomized to optimal medical therapy with or without PCI: pre-specified subset analysis of the COURAGE trial. Accepted for presentation at the 80th Annual Scientific Sessions of the American Heart Association Meetings. *Circulation* 2007;116 (Suppl II):II-538.

46. Boden WE, Teo KK, Hartigan PM, Weintraub WS, Maron DJ, Kostuk WJ, Chaitman BR, Mancini J, Spertus JA, Dada MR, Booth DC, O'Rourke RA. Impact of optimal medical therapy with or without PCI on long-term cardiovascular endpoints in patients with stable coronary artery disease: Tertiary outcomes from the COURAGE trial. Accepted for presentation at the 80th Annual Scientific Sessions of the American Heart Association Meetings. *Circulation* 2007;116 (Suppl II):II-538.

47. Morrow DA, Scirica BM, Chaitman BR, Murphy SA, Karwatowska-Prokopczuk E, McCabe CH, Braunwald E. Effective of ranolazine on hemoglobin A1c in the MERLIN-TIMI 36 randomized controlled trial. Accepted for presentation at the 80th Annual Scientific Sessions of the American Heart Association Meetings. *Circulation* 2007;116 (Suppl II):II-539.

48. Dolan MS, Bierig M, Beitinjaneh B, Kolli S, Baroudi S, Chaitman B, Labovitz AJ. Does myocardial perfusion imaging during Dobutamine stress echocardiography provide incremental prognostic information in women with suspected coronary artery disease? Accepted for presentation at the 79th Annual

Scientific Sessions of the American Heart Association Meetings, November 2006. *Circuation* 2006;114:II-480.

49. Stone PH, Chaitman B, Koren A, Crager M. Effects of Ranolazine as monotherapy and combination therapy on rate pressure product at rest and during exercise: Results from the MARISA and CARISA trials. Accepted for presentation at the 79th Annual Scientific Sessions of the American Heart Association Meetings, November 2006. *Circulation* 2006;114:II-715.

50. Chaitman BR, Mentzer RM, Penasche P, Gavard JA, Schwann NM, Jaffe AS. Differential Impact of Troponin Assay on Estimates of Six Month Mortality after Coronary Artery Bypass Graft (CABG) Surgery. Accepted for poster presentation at the European Society of Cardiology World Congress of Cardiology meeting, September. *Eur Heart J* 2006;27:271.

51. Vetrovec GW, Meyhan S, Watson J, Chaitman B, Cody, Wenger N. African Americans with chronic angina: risk factors and treatment profiles compared to Caucasians. Accepted for poster presentation at the National Scientific Sessions of the American College of Cardiology meetings, March 2006. J Am Coll Cardiol 2006;47:210A.

52. Dolan MS, Bierig M, Kolli S, Ahmed F, Kassar S, St. Vrain J, Chaitman B, Labovitz AJ. Can normal myocardial perfusion during dobutamine stress echocardiography predict a good long term prognosis in women? J Am Coll Cardiol 2006;47:152A.

53. Dolan MS, Kolli S, Bierig M, St. Vrain J, Chaitman B, Labovitz AJ. The role of sub maximal dobutamine stress echocardiography in patients undergoing non-cardiac surgery. Circulation 2005;112:II-668.

54. Dolan MS, Kolli S, Bierig M, St. Vrain J, Chaitman B, Labovitz AJ. Does dobutamine stress echocardiography provide incremental value for the prediction of mortality in female patients with diabetes mellitus? Circulation 2005;112:II-827.

55. Dolan MS, Bierig M, Kolli S, St. Vrain J, Chaitman B, Labovitz AJ. Does left ventricular diastolic function assessed by Doppler echocardiography in patients with impaired systolic function following first acute myocardial infarction have prognostic significance? Accepted for presentation at the 16th Annual Scientific Sessions of the American Society of Echocardiography, June 15-18, 2005. *Am Soc Echocardiography* 2005;18:40.

56. Dolan MS, Kolli S, Kassar S, Bierig M, St. Vrain J, Chaitman B, Labovitz. Can normal dobutamine stress echocardiography predict a good long-term prognosis in women? Accepted for presentation at the 16th Annual Scientific Sessions of the American Society of Echocardiography, June 15-18, 2005. *Am Soc Echocardiography* 2005;18:66.

57. Schwartz GG, Olsson AG, Chaitman B, Goldberger J, Szarek M, Sasiela WJ. Effect of intensive statin treatment on the occurrence of atrial fibrillation after acute coronary syndrome. An analysis of the MIRACL trial. Accepted for presentation at the 77th Annual Scientific Sessions of the American Heart Association Meetings, November 2004. Circulation 2004;110:III-740.

58. Vicaril RM, Smith WB, Chaitman B, Chrysant SG, Tonkon MJ, Bittar N, Weiss RJ, Thadani U, for the Fasudil Study Group. A randomized double-blind placebo-controlled phase II study: The efficacy of Fasudil in patients with stable angina. European Society of Cardiology Congress Meeting, Munich, Germany, 2004. Eur Heart J 2004

59. Vicari RM, Chaitman B, Keefe D, Smith WB, Chrysant SG, Tonkon MJ, Bittar N, Weiss R, Thadani U. A randomized double-blind placebo-controlled phase 2 study on the efficacy and safety of fasudil in patients with stable angina. Accepted for presentation at the 53rd Annual Scientific Sessions of the American

College of Cardiology Meetings, March 2004. *J Am Coll Cardiol* 2004;43:254A.

60. Vetrovec G, Watson J, Chaitman B, Cody R, Wenger N. Symptoms persist in patients with chronic angina despite frequent anti-anginal use and prior revascularization. Accepted for presentation to the 53rd Annual Scientific Sessions of the American College of Cardiology Meetings, March 2004. *J Am Coll Cardiol* 2004;43(suppl A):281A.

61. Parker JO, Chaitman B, Skopal J, Chumakova G, Kuch J, Wang W, Skettino W, Wolff A. Rebound worsening in exercise performance was not observed after abrupt ranolazine withdrawal in patients with chronic angina in CARISA. European Society of Cardiology Congress Meeting, Vienna, Austria, 2003. Eur Heart J 2003;24:20.

62. Chaitman B, Skettino S, Jerling M, Skopal J, Chumakova G, Kuch J, Wang W, Wolff A. Ranolazine decreases hemoglobin A1C (HbA1c) in angina patients with diabetes: Carbohydrate and lipid parameters in MARISA and CARISA. European Society of Cardiology Congress Meeting, Vienna, Austria, 2003. Eur Heart J 2003;24:21.

63. Shaw LJ, Olson M, Kelsey S, Chaitman BR, Sopko G, Merz CNB. Using estimated functional capacity to optimize stress testing for diagnosis and prognosis of cardiovascular disease in women: The NHLBI-sponsored WISE Study. Accepted for presentation to the 52nd Annual Scientific Sessions of the American College of Cardiology Meetings, March 2003. *J Am Coll Cardiol* 2003;41:177A.

64. Sakai S, Gavard JA, Stocke K, Chaitman BR, for the GUARDIAN Investigators. Analysis of ST segment shift in lead aVF improves short term prognostic risk stratification in the acute coronary syndromes. Accepted for presentation to the 52nd Annual Scientific Sessions of the American College of Cardiology Meetings, March 2003. *J Am Coll Cardiol* 2003;41:402A.

65. Gavard JA, Chaitman BR, Sakai S, Stocke K, Danchin N, Erhardt L, Chi E, Jessel A, Gallo R, Theroux P, for the GUARDIAN Investigators. Predicting early coronary revascularization after an acute coronary syndrome. Accepted for presentation to the 52nd Annual Scientific Sessions of the American College of Cardiology Meetings, March 2003. *J Am Coll Cardiol* 2003;41:367A.

66. Puri S, Chaitman BR, Gavard JA, Sakai S, Stocke K, Erhardt L, Chi E, Jessel A, Gallo R, Theroux P, for the GUARDIAN Investigators. Diabetes does not add to the increased 6-month mortality associated with increase in CK-MB after PCI. Accepted for presentation to the 52nd Annual Scientific Sessions of the American College of Cardiology Meetings, March 2003. *J Am Coll Cardiol* 2003;41:55A.

67. Chaitman BR, Skettino S, Pepine CJ, Parker JO, Skopal J, Chumakova G, Kuch J, Wang W, Wolff AA. Ranolazine increases exercise performance and decreases hemoglobin A1C in angina patients with diabetes. Accepted for presentation to the 52nd Annual Scientific Sessions of the American College of Cardiology Meetings, March 2003. *J Am Coll Cardiol* 2003;41:378A.

68. White HD, Skettino S, Chaitman BR, Pepine CJ, Parker JO, Skopal J, Chumakova G, Kuch J, Wang W, Wolff AA. Anti-anginal efficacy of ranolazine addition to beta blocker or calcium antagonist therapy in patients with a history of heart failure. Accepted for presentation at the 75th Annual Scientific Sessions of the American Heart Association Meetings, November 2002. Circulation 2002;106:II349-50.

69. Chaitman BR, Skettino S, Parker JO, Skopal J, Chumakova G, Kuch J, Wang W, Wolff AA. Efficacy of ranolazine as add-on therapy for chronic angina in elderly patients. Accepted for presentation at the 75th Annual Scientific Sessions of the American Heart Association Meetings, November 2002. Circulation 2002;106:II-330.

70. Chaitman B, Sakai S, Hasan F, Gavard J, Stocke K, Theroux P, GUARDIAN Investigators. Do all Q waves after coronary bypass surgery impact 6-month prognosis? Annual Scientification Sessions of the American College of Cardiology Meetings, March 2002. J Am Coll Cardiol 2002;39:3358A.

71. Chaitman BR, for the CARISA Investigators. Improved exercise capacity using a novel pFOX inhibitor as antianginal therapy: results of the combination assessment of Ranolazine in stable angina (CARISA). Circulation 2001;104(25):1B*e*-4B*e*; Late-Breaking Clinical Trial Abstract available at www.ahajournals.org.

72. Boyce SW, Bartels C, Bolli R, Chaitman B, Chen JC, Chi E, Jessell A, Kereiakes D, Knight J, Thulin L, Theroux P. Impact of sodium-hydrogen exchange inhibition by cariporide on death or myocardial infarction in high risk CABG surgery patients. Results of the CABG surgery cohort of the GUARDIAN study. Accepted for presentation at the 74th Annual Scientific Sessions of the American Heart Association Meetings, November 2001. Circulation 2001;104:II-687.

73. Gavard JA, Chaitman BR, Sakai S, Stocke K, Boyce S, Theroux P, for the GUARDIAN Investigators. Does elevated CK-MB after coronary bypass surgery have the same prognostic significance as after an acute coronary syndrome? Accepted for presentation at the 74th Annual Scientific Sessions of the American Heart Association Meetings, November 2001. Circulation 2001;104:II-597.

74. Sakai S, Chaitman BR, Gavard JA, Stocke K, Danchin N, Erhardt L, Theroux P, for the GUARDIAN Investigators. Increasing the pre-test likelihood estimate for non ST-elevation myocardial infarction in acute coronary syndrome. Results from the GUARDIAN trial. Accepted for presentation at the 74th Annual Scientific Sessions of the American Heart Association Meetings, November 2001. Circulation 2001;104:II-649.

75. Sakai S, Chaitman BR, Gavard JA, Stocke K, Danchin N, Erhardt L, Gallo R, Theroux P, for the GUARDIAN Investigators. Predicting six month mortality in acute coronary syndromes: results from the GUARDIAN Trial. Accepted for presentation at the 74th Annual Scientific Sessions of the American Heart Association Meetings, November 2001. Circulation 2001;104:II-697.

76. Theroux P, Chaitman BR, Danchin N. Inhibition of the Sodium-Hydrogen Exchanger with Cariporide to Prevent Myocardial Infarction in High-Risk Ischemic Situations Main Results of the GUARD During Ischemia Against Necrosis (GUARDIAN) Trial. ACC Current J Review 2001;10:17.

77. Lawrence JH, Ivleva I, Shlyakhto E, Ujda M, Lenis J, Toth C, Stieber D, Reisin L, Pangerl A, Friedman J, Chaitman BR. Omapatrilat: novel vasopeptidase inhibitor with anti-ischaemic and anti-anginal activity in a placebo-controlled trial in stable, effort-induced angina pectoris. Eur Heart J 2001;22:291A.

78. Chaitman BR, Skettino S, DeQuattro V, Hanley PC, Jansky, Kuch JK, Parker JO, Nelson JJ, Hebert D, Wolff AA. Improved exercise performance on Ranolazine in patients with chronic angina and a history of heart failure: the trial. J Am Coll Cardiol 2001;37:149A.

79. DeQuattro V, Skettino S, Chaitman BR, Hanley PC, Jansky P, Kuch JK, Parker JO, Nelson JJ, Hebert D, Wolff AA. Comparative antianginal efficacy and tolerability of Ranolazine in diabetic and nondiabetic patients: results of the MARISA trial. J Am Coll Cardiol 2001;37:338A.

80. El-Shafei A, Klatte K, Gavard J, Stocke K, Keller B, Jessel A, Theroux P, Chaitman B. The Clinical Significance of Minimal Enzyme "Leaks" after Percutaneous Coronary Interventions. Accepted for presentation to the

73rd Annual Scientific Session of the American Heart Association in New Orleans, November 2000. Circulation 2000;102(18):II-752.

81. Jansky P, Skettino S, Chaitman B, Dequattro V, Hanley P, Kuch JK, Parker JO, Nelson JJ, Hebert D, Wolff AA. Comparative Antianginal Efficacy of Ranolazine in Young (<65 years) Versus Elderly (≥65 years) Patients: Results of the Marisa Trial. Accepted for presentation to the 73rd Annual Scientific Session of the American Heart Association in New Orleans, November 2000. Circulation 2000;102(18):II-712.

82. Klatte K, Gavard J, Stocke K, Keller B, Jessel A, Theroux P, Chaitman B. Utility of Post-Procedure CK-MB Ratio and ECG Changes in Clinical Trials to Predict Early Mortality Following Coronary Bypass Surgery. Accepted for presentation to the 73rd Annual Scientific Session of the American Heart Association in New Orleans, November 2000. Circulation 2000;102(18):II-556.

83. Klatte K, El-Shafei A, Gavard J, Stocke K, Keller B, Jessel A, Theroux P, Chaitman B. Are New ST-T wave Changes Predictive of 6 Month Mortality Following Percutaneous Coronary Interventions? Accepted for presentation to the 73rd Annual Scientific Session of the American Heart Association in New Orleans, November 2000. Circulation 2000;102(18):II-685.

84. Krone RJ, Hardison RM, Chaitman BR, Gibbons RJ, Sopko G, Bach R, Detre KM. Risk stratification one year after successful coronary revascularization, the lack of a role for routine exercise testing. 2000;3:41. Presented at the Third international conference on Coronary disease, Lyon France, October 2000.

85. Faizullah S, Yokoyama Y, Islam S, Sidighi S, Gussak I, Chaitman B. Definition of Q wave myocardial infarction after coronary revascularization. Implications for clinical trial design. Circulation 1999;100(18):I-85 and presented to the 72nd Annual Scientific Session of the American Heart Association, November 1999.

86. Lin L, Lewis JF, Kerensky RA, McGorray SP, Boyette AF, Chaitman BR, Pepine CJ. Exercise treadmill testing in women with suspected myocardial ischemia: New findings using ACIP protocol: NHLBI Women's Ischemia Syndrome Evaluation (WISE). J Am Coll Cardiol 1999;33(suppl A):327A.

87. Krone RJ, Hardison R, Chaitman BR. The ability to take an exercise test one year after revascularization is an important predictor of five year survival. Circulation 1998;98(17):I-710.

88. Yokoyama Y, Chaitman BR, Hardison R, Krone R, Stocke K, Gussak I, Attubato MJ, Rautaharju PM, Sopko G, Detre KM. Prognostic impact of new post-procedure ECG abnormalities after coronary bypass surgery as compared to coronary angioplasty in BARI. Circulation 1998;98(17):I-476.

89. Yokoyama Y, Fayyaz I, Chaitman BR, Merkle B, Miller DD. Accurate cardiac event prediction using combined exercise peak oxygen uptake and stress myocardial perfusion tomography in congestive heart failure patients: A 1 year "crack" in the poor prognostic "window"? Circulation 1998;98(17):I-371.

90. Stone PH, Thompson B, Zaret BL, Chaitman B, Gibson RS, Schweiger MJ, Steingart R, Thompson C, Fung A, McCabe C, Knatterud G, Braunwald E. Factors associated with failure of medical therapy in patients with unstable angina and non-Q wave myocardial infarction in TIMI 3B. Circulation 1998;98(17):I-492.

91. Chaitman BR, Hardison RM, Rosen AD, Abhayakumar A, Stocke K, Bourassa MG, Rautaharju PM, Sopko G, Detre K. Differential prognostic impact of baseline ECG abnormalities after coronary revascularization in the BARI trial.Circulation 1997;96(8):I-459.1

92. Chaitman BR, Osada N, Miller LW, Yip DS, Cishek MB, Wolford TL, Donohue TJ.

Exercise systolic blood pressure and percent predicted peak VO2 further enhance prognostic risk stratification in ambulatory patients with chronic heart failure and a peak exercise VO2 ≤14 ml/min/kg referred for cardiac transplantation. Circulation 1997;96(8):I-85.

93. Chaitman BR, Hardison RM, Rosen AD, Miller M, Dimas A, Bourassa MG, Sopko G, Detre K, and the BARI Investigators. Impact of prior myocardial infarction on 5 year cardiac mortality after coronary angioplasty or bypass surgery in the BARI trial. Circulation 1997;96(8):I-647.

94. Jacobs AK, Bourassa MG, Kip KE, Sopko G, Rosen AD, Chaitman BR, Schwartz L, Whitlow PL, Sharaf BL, Kellett MA, Shemin RJ. Incomplete revascularization via PTCA vs. CABG: The Bypass Angioplasty Revascularization Investigation (BARI). Circulation 1997;96(8):I-456.

95. Chaitman BR. Workshop on the Standards for Core ECG Laboratories. Coding of Serial ECG Changes in a Large Multicenter Clinical Trial- The BARI Experience. XXIVth International Congress on Electrocardiology. Bratislava, Slovak Republic, June 24-28, 1997.

96. Rautaharju P, Chaitman BR. Workshop on the Standards for Core ECG Laboratories. The New Novacode-A Comprehensive ECG Coding System with Criteria and Definitions for Classification of Prevalent and Incident ECG Abnormalities. XXIVth International Congress on Electrocardiology. Bratislava, Slovak Republic, June 24-28, 1997.

97. Cha YM, Osada N, Stelken A, Donohue T, Wolford T, Cishek MB, Miller LW, Chaitman BR. Does pulmonary hypertension precardiac transplantation impact on post-transplant exercise capacity? J Am Coll Cardiol 1997;29(2):182A.

98. Chaitman BR (panel participant). Can we improve the diagnosis of coronary artery disease in women?. Coronary artery disease in women: What have we learned. American College of Cardiology 46th Annual Scientific Session, March 16-19, 1997, Anaheim, California.

99. Castello R, Osada N, Dolan MS, Yip D, Donohue T, Miller L, Chaitman B, Labovitz A. Echocardiographic outcome predictors differ in patients with ischemic versus nonischemic cardiomyopathy. Presented at the 5th World Congress on Heart Failure – Mechanisms and Management, Washington, D.C., May 11-14, 1997

100. Jacobs AK, Kelsey SF, Brooks MM, Chaitman BR, Faxon DP, Ryan TJ, Detre KM. Improved outcome for women undergoing coronary revascularization: a report from the Bypass Angioplasty Revascularization Investigation (BARI). Presented at the 69th Annual Scientific Sessions of the American Heart Association. November 10-13, 1996. Circulation 1996;94(8):I-205.

101. Bora PS, Guruge BL, Miller DD, Chaitman BR, Ruyle MS. Molecular characterization of human heart fatty acid ethyl synthase/carboxylesterase. J Molecular and Cellular Cardiology 1996;28:176A.

102. Mistry B, Hoff J, Linsey L, Aridge D, Contis J, Solomon H, Younis Y, Chaitman B. Dipyridamole thallium 201 screening as a predictor of perioperative cardiac events in diabetics undergoing kidney or kidney-pancreas transplantation. Presented to the 15th Annual Scientiic Meeting of the American Society of Transplant Physicians. May 26-29, 1996.

103. Osada N, Chaitman BR, Stelken AM, Donohue TJ, Wolford TL, Miller LW. Long term cardiopulmonary exercise performance after heart transplantation. Presented at the 69th Annual Scientific Sessions of the American Heart Association. November 10-13, 1996, New Orleans. Circulation 1996;94(8):I-290.

104. Whitlow PL, Bashore TM, Bourassa MG, Chaitman BR, Andrews KH, Rosen AD, Stadius ML, Sopko G, Alderman EL. Relationship of

extent of revascularization with angina at one year in patients randomized to PTCA or CABG in Bypass Angioplasty Revascularization Investigation (BARI). Presented at the 69th Annual Scientific Sessions of the American Heart Association. November 10-13, 1996, New Orleans. Circulation 1996;94(8):I-318.

105. Jacobs AK, Kelsey SF, Brooks MM, Chaitman BR, Faxon DP, Ryan TJ, Detre KM. Improved outcome for women undergoing coronary revascularization: a report from the Bypass Angioplasty Revascularization Investigation (BARI). Presented at the 69th Annual Scientific Sessions of the American Heart Association. November 10-13, 1996, New Orleans. Circulation 1996;94(8):I-205.

106. Pahlm US, Chaitman BR, Rautaharju PM, Selvester RH, Wagner GS. Comparison of various electrocardiographic methods for estimating myocardial infarct size. Presented at the 69th Annual Scientific Sessions of the American Heart Association. November 10-13, 1996, New Orleans. Circulation 1996;94(8):I-371.

107. Mahmarian JJ, Moye LA, Chinoy DA, Sequeira RF, Habib GB, Henry WJ, Jain A, Chaitman BR, Weng CS, Morales-Ballejo H, Pratt CM. Transdermal nitroglycerin patch therapy improves left ventricular function and prevents remodeling after acute myocardial infarction: results of a multicenter randomized double-blind placebo controlled trial. Presented at the 69th Annual Scientific Sessions of the American Heart Association. November 10-13, 1996, New Orleans. Circulation 1996;94(8):I-504.

108. Chaitman BR, Schwartz L, Roubin GS, Lytle BW, Hardison RM, Sopko G, Williams DO, Stack RS, Kouchoukas NT, Kellett MA, and the BARI investigators. Comparative 5 year incidence of ischemic events for PTCA and CABG in the Bypass Angioplasty Revascularization Investigation (BARI). Presented at the 46th Annual Scientific Sessions of the American College of Cardiology. J Am Coll Cardiol 1996;27(2):55A.

109. Pepine CJ, Mark D, Bourassa M, Chaitman B, Knatterud G, Forman S, Pratt C, Sopko G, Conti CR. Cost implications for treatment of cardiac ischemia: an ancillary Asymptomatic Cardiac Ischemia Pilot (ACIP) study. Presented at the 46th Annual Scientific Sessions of the American College of Cardiology. J Am Coll Cardiol 1996;27(2):186A.

110. Chaitman BR, Jacobs AK, Ohman EM, Krone RJ, Mullany CJ, Sopko G, Gussak I, Sutton-Tyrrell K, Rosen AD, and the BARI investigators. Periprocedure myocardial infarction rates in the Bypass Angioplasty Revascularization Investigation (BARI). Presented at the 46th Annual Scientific Sessions of the American College of Cardiology. J Am Coll Cardiol 1996;27(2):361A.

111. Bourassa MG, Knatterud GL, Pepine CJ, Sopko G, Rogers WJ, Geller NL, Dyrda I, Forman SA, Chaitman BR, Conti CR for the ACIP investigators. Asymptomatic Cardiac Ischemia Pilot (ACIP) study: improvement of cardiac ischemia at 1 year and CABG. Eur Heart J 1995;16:253.

112. Merritt RF, Farrar M, Guruge BL, Miller DD, Chaitman BR, Bora PS. Moderate alcohol consumption prevents restenosis in an atherogenic rabbit model. Presented at the 68th Annual Scientific Sessions of the American Heart Association. Anaheim, California. Circulation 1995;92(8):I-34.

113. Brener S, Cohen M, Talley JD, Eagle K, Gershony G, Chaitman B, Benitez RM, Altmann D, Blankenship J, Domanski M, Ellis S for the PRE-OP investigator group. Striking hospital to hospital variation in preoperative cardiac work-up for patients referred for major non-cardiac surgery. Presented at the 68th Annual Scientific Sessions of the American Heart Association. Anaheim, California. Circulation 1995;92(8):I-34. Circulation 1995;92(8):I-679.

114. Bora PS, Farrar MA, Guruge BL, Lange LG, Miller DD, Chaitman BR, Merritt RF. Moderate alcohol consumption prevents restenosis in rabbit model. XII International Symposium on Drugs Affecting Lipid Metabolism. Houston, Texas, November 7, 1995.

115. Sharaf BL, Bourassa MG, Pepine CJ, Chaitman BR, Williams DO, Miele NJ, Davies RF, McMahon RP, Proschan M, Conti CR for the ACIP investigators. Clinical and demographic findings in patients with ischemia and normal coronary arteries: an ACIP ancillary study. Presented at the 44th Annual Scientific Sessions of the American College of Cardiology. New Orleans, Louisiana. J Am Coll Cardiol 1995;411A.

116. Pepine CJ, Chaitman BR, Pratt C, Bourassa MG, Stone PH, Knatterud GL, Forman S, Sopko G, Conti CR for the ACIP study group. Absence of ischemia on ambulatory ECG monitoring during treatment as a predictor of outcome: a report from the ACIP study. Presented at the 44th Annual Scientific Sessions of the American College of Cardiology. New Orleans, Louisiana. J Am Coll Cardiol;1995;312A.

117. Stone P, Chaitman BR, McMahon T, Andrews T, Sopko G, Pratt C, Rogers W, Raby K, Frishman W, Hill J, Conti R for the ACIP investigators. A comparison of exercise-induced and ambulatory ischemia in patients with stable coronary disease: an ACIP data bank study. Presented at the 67th Annual Scientific Sessions of the American Heart Association. Circulation 1994;90:I559.

118. Chaitman B, Stone P, Knatterud G, Forman S, Sopko G, Bourassa M, Pratt C, Rogers W, Conti CR for the ACIP investigators. Exercise test results in the Asymptomatic Cardiac Ischemia Pilot (ACIP) study: impact of anti-ischemia therapy on 12 week outcome. Presented at the 67th Annual Scientific Sessions of the American Heart Association. Circulation 1994;90:I-328.

119. Bourassa M, Pepine C, Forman S, Rogers W, Stone P, Chaitman B, Mahmarian J, Sopko G, Conti C for the ACIP investigators. Effects of coronary angioplasty and coronary artery bypass graft surgery on recurrent angina and ischemia in the Asymptomatic Cardiac Ischemia Pilot (ACIP) study. Presented at the 67th Annual Scientific Sessions of the American Heart Association. Circulation 1994;90:I-530.

120. Chaitman BR, Tamesis B, Terry A, Russell K, Stocke K, Kargl D, Wiens RD, Rautaharju P. Software based use of Minnesota code criteria for serial ECG classifcation in large scale clinical trials. XIIth World Congress of Cardiology Meetings, Berlin, Germany September 10-14, 1994.

121. Stelken AM, Younis LT, Jennison SH, Wolford TL, Miller LW, Miller DD, Chaitman BR. Improved risk stratification of ambulatory congestive heart failure patients using age and gender adjusted percent predicted peak exercise oxygen uptake. Presented at the 43rd Annual Scientific Sessions of the American College of Cardiology. Atlanta, Georgia. J Am Coll Cardiol 1994;448A.

122. Stelken AM, Younis LT, Vaughn LM, Anthonis D, Jennison SJ, Wolford TL, Miller DD, Miller LW, Chaitman BR. Improved risk stratification of heart failure patients using exercise VO2 and echocardiographic indexed left ventricular mass. Presented at the 43rd Annual Scientific Sessions of the American College of Cardiology.Atlanta, Georgia. J Am Coll Cardiol 1994;400A.

123. Fuchs J, McCabe CH, Antman EM, Borzak S, Palisaitis D, Herson S, Palmeri S, Sequeira R, Sharma G, Diver D, Warnica W, Mueller H, Magorian R, Goldberg N C, Williams DO, Rernetz M, Chakko S, Chaitman B, Cannon CP, Adelman B, Maraganors J, Braunwald E for the TIMI 7 investigators. Hirulog in the treatment of unstable angina: results of the TIMI 7 trial. Presented at the 43rd Annual Scientific Sessions of the American College of Cardiology. Atlanta, Georgia. J Am Coll Cardiol 1994;56A.

124. Jacobs AK, Kelsey S, Meivin J, Rogers A, Macado M, Chaitman B, Faxon D, Detre K, and the BARI investigators. Gender differences in refusal to participate in a randomized trial: a report from the Bypass Angioplasty Revascularization Investigation (BARI). Presented at the 43rd Annual Scientific Sessions of the American College of Cardiology. Atlanta, Georgia. J Am Coll Cardiol 1994;455A.

125. Kern MJ, Al-Joundi B, Donohue T, Bach R, Caracciolo E, Aguirre F, Chaitman BR, Miller DD. Attenuation of dipyridamole-induced coronary hyperemia by aminophylline: an analysis by continuous quantitative intracoronary spectral flow velocity. Cath and Cardiovasc Diagnosis 1993;29:81.

126. Stratmann HG, Tamesis B, Wittry MD, Younis LT, Wiens RD, Chaitman BR, Miller DD. Dipyridamole sestamibi myocardial tomography: an independent predictor of adverse outcome in unstable angina patients. Presented to the 66th Annual Scientific Sessions of the American Heart Association. Atlanta, Georgia. Circulation 1993;88:I-487.

127. Stratmann HG, Tamesis BR, Younis LT, Caralis DG, Wittry MD, Chaitman BR, Miller DD. Dipyridamole sestamibi tomography optimizes perioperative outcome and defines late prognosis in vascular surgery patients. Presented to the 66th Annual Scientific Sessions of the American Heart Association. Atlanta, Georgia. Circulation 1993;88:I-440.

128. Taylor HA, Mickel M, Rogers WJ, Chaitman BR. Does access to coronary bypass graft surgery improve long-term survival in African Americans with coronary artery disease? Presented to the 66th Annual Scientific Session. Atlanta, Georgia. Circulation 1993;88:I-387.

129. Cannon CP, McCabe CH, Diver DJ, Herson S, Greene RM, Shah PK, Sequeira RF, Leya F, Kirshenbaum JM, Magorien RD, Palmeri S, Dangoisse V, Flaker GC, Davis V, Chaitman BR, Wackers RJ, Zaret BL, Gibson CM, Poole WK, Braunwald E for the TIMI 4 investigators. Clinical benefit of front-loaded tPA over combination thrombolytic therapy or APSAC for acute MI: results of the TIMI 4 trial. Presented to the 66th Annual Scientific Session. Atlanta, Georgia. Circulation 1993;88:I-291.

130. Kern M, Donohue T, Bach R, Aguirre F, Caracciolo E, Mechem C, Cauley M, Flynn M, Chaitman B. Clinical outcome of deferred angioplasty in patients based on normal tranlesional pressure-flow velocity measurements. Presented to the 66th Annual Scientific Sessions. Atlanta, Georgia. Circulation 1993;88:I-204.

131. Aguirre FV, Werth D, hamilton W, Al-Joundi B, Flynn M, Armbruster R, Stonner T, Chaitman B for the t-PA Heparin Trial investigators. Influence of intravenous heparin duration on clinical outcome of patients receiving accelerated weight-adjusted rt-PA for acute myocardial infarction: Preliminary results of the Multicenter Randomized t-PA Heparin Duration Trial. Presented to the 66th Annual Scientific Sessions. Atlanta, Georgia. Circulation 1993;88:I-201.

132. Chaitman BR, Froelicher V (co-directors). Clinical exercise physiology and cardiac rehabilitation conference. Exercise testing, diagnosis, disease severity. The American College of Cardiology extramural program. Palo Alto, CA August 12-14, 1993.

133. Kern MJ, Al-Joundi B, Donohue TJ, Bach RG, Caracciolo EA, Aguirre FV, Chaitman BR, Miller DD. Reversal of dipyridamole-induced coronary hyperemia by aminophylline: and analysis by continuous quantitative intracoronary spectral flow velocity. Society for Cardiac Angiography and Interventions. The 16th Annual Meeting-May 18-22, 1993 (presented).

134. Stratmann HG, Tamesis BR, Wittry MD, Younis LT, Wiens RD, Chaitman BR, Miller DD. Dipyridamole stress technetium-99M sestamibi myocardial tomography: an independent predictor of adverse outcome in

patients following acute ischemia events. The Society of Nuclear Medicine 40th Annual Meeting, Toronto, Ontario, Canada, June, 1993.

135. Chaitman BR, Wittry MD, Goodgold HM, Wiens RD, Chaitman BR, Miller DD. Cardiomyopathic left venticular dilatation: a significant cause of decreased specificity in myocardial technetium-99M sestamibi tomography. The Society of Nuclear Medicine 40th Annual Meeting, Toronto, Ontario, Canada, June, 1993.

136. Chaitman BR, Froelicher V. Exercise nuclear cardiology and stress echocardiography: the noninvasive assessment of ischemic heart disease. Pharmacologic vasodilators: alternatives to exercise. Noninvasive post infarct workup: should it be different after thrombolytics? Heart House Learning Center, American College of Cardiology June 2-4, 1993.

137. Miller DD, Tamesis BR, Wittry MD, Younis LT, Wiens RD, Chaitman BR, Stratmann HG. Dipyridamole technetium-99m sestamibi myocardial tomography: an independent predictor of adverse outcome in patients following acute ischemic events. 1st International Congress of Nuclear Cardiology, Cannes, France, April 25-28, 1993.

138. Miller DD, Tamesis BR, Younis LT, Caralis DG, Wittry MD, Chaitman BR, Stratmann HG. Preoperative risk stratification with dipyridamole sestamibi tomgraphy optimizes perioperative outcome and defines late prognosis in patients evaluated for vascular surgery. 1st International Congress of Nuclear Cardiology, Cannes, France, April 25-28, 1993.

139. Weiner DA, Ryan TJ, Chaitman BR, Parson L, Trastani LF, and the CASS investigators. Differential effects of coronary bypass surgery in men and women based on exercise testing. Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;206A.

140. Donohue T, Kern MJ, Miller DD, Bach R, Labovitz AJ, Chaitman BR, Caracciolo E, Aguirre FV. Improved decision making for coronary interventions: comparisons of intracoronary lesion flow dynamics vs. ischemic stress testing. Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;21:152A.

141. Jacobs AK, Kesley S, Rosen A, Chaitman B, Faxon DP, Ryan TJ, Detre K, and the BARI investigators. Gender differences in patients undergoing coronary revascularization: a report from the Bypass Angioplasty Revascularization Investigation (BARI) trial. Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;21:272A.

142. Al-Joundi B, Kern MJ, Donohue T, Bach R, Aguirre F, Chaitman BR, Miller DD. Is intravenous dipyridamole coronary hyperemia reversal by aminophylline equivalent to adenosine cessation? Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;21:420A.

143. Aguirre F, Werth D, Gudipati C, Pedersen W, Lewen M, Wise N, Changlani M, Al-Joundi B, Flynn M, Stonner T, Kern MJ, Chaitman BR. Factors limiting effective heparinization following thrombolysis for acute myocardial infarction: interim findings for the t-PA Heparin Duration Trial. Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;21:136A.

144. Stratmann HG, Tamesis BR, Younis LT, Wittry MD, Goodgold HM, Chaitman BR, Miller DD. Prognostic value of dipyridamole technetium-99m sestamibi myocardial imaging >300 consecutive patients with stable chest pain. Presented to the 41st Annual Scientific Sessions of the American College of Cardiology.

Anaheim, California. J Am Coll Cardiol 1993;21:68A.

145. Stratmann HG, Tamesis BR, Younis LT, Wittry MD, Wiens RD, Chaitman BR, Miller DD. Dipyridamole sestamibi myocardial imaging for cardiac risk assessment before nonvascular surgery: does every operation demand a preoperative stress study? Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;21:207A.

146. Shaw LJ, Romeis JC, Kargl DJ, Younis LT, Chaitman BR, Miller DD. Validation of a gender-based scoring system for coronary disease detection and risk stratification in 840 consecutive patients: a method of improving health care delivery. Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;21:217A.

147. Tamesis B, Terry A, Russell K, Stocke K, Kargle D, Wiens RD, Rautaharju P, Chaitman BR. Software based use of Minnesota code criteria for serial ECG classification in large scale clinical trials. Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;21:4A.

148. Caracciolo EA, Kaiser GC, Schaff H, Taylor HA, Sopko G, Davis K, Chaitman BR for the CASS investigators. Medical and surgical therapy for left main equivalent coronary artery disease: long term CASS experience. Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;21:152A.

149. Tamesis B, Ast M, Stelken A, Byers S, Chaitman BR. Diagnostic accuracy of ST/heart rate slope measurements using four treadmill exercise protocols. Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;21:97A.

150. Tamesis B, Stelken A, Byers S, Shaw L, Younis L, Miller DD, Chaitman BR. Hemodynamic comparison of the ACIP and modified ACIP versus Bruce and Cornell exercise protocols. Presented to the 41st Annual Scientific Sessions of the American College of Cardiology. Anaheim, California. J Am Coll Cardiol 1993;21:96A.

151. Albert SG, Gomez CR, Russell S, Chaitman B, Bernbaum M, Kong BA. Paradoxical cerebrovascular response to oxygen supplementation among diabetics. Presented at the 7th International Symposium on Cerebral Hemodynamics. February 8-10, 1993. Lake Buena Vista, Florida.

152. Cannon CP, McCabe CH, Chaitman BR, Kirshenbaum J, Herson S, Nasmith JB, Thompson B, Braunwald E. Clinical variables that distinguish non-Q wave MI from unstable angina in patients with acute coronary ischemia: an analysis from the TIMI-3B trial. Circulation 1992;86:I-388.

153. Cannon CP, Theroux P, Gibson R, Kufera J, Feldman T, Chaitman B, McCabe CH, Braunwald E. Clinical profile of 4600 patients with unstable angina and non-Q wave MI; results of the TIMI-3 registery. Circulation 1992;86:I-387.

154. Younis LT, Yip D, Takase B, Stelken AM, Merkle EJ, Miller DD, Chaitman BR, Miller LW. Prognostic role of cardiopulmonary exercise testing in patients being evaluated for heart transplantation. Circulation 1992;86:I-399.

155. Miller DD, Donohue TJ, Byeres SL, Bach RG, Aguirre FV, Younis LT, Wittry MD, Goodgold HM, Chaitman BR, Kern MJ. Adenosine technetium-99m Sestamibi myocardial tomographic correlates of post-stenotic intracoronary Doppler flow reserve: preliminary evidence against a hyperemic "roll-off" in tracer extraction in man. Circulation 1992;86:I-506.

156. Miller DD, Craig FE, Dressler FA, Farraf MA, Breland CM, Bach RG, Donohue TJ, Chaitman BR, Aguirre FV. Immunohistochemical characterization of the lymphoid/mononuclear cell composition of human atherectomy tissue: correlation with interleukin-2 receptor expression. Circulation 1992;86:I-800.

157. Weiner DA, Ryan TJ, Parsons L, Fisher LD, Chaitman BR, Sheffield LT, Traistani FE. The significance of silent myocardial ischemia during exercise testing in women. Circulation 1992;86:I-116.

158. Chaitman BR, Froelicher V (co-directors). Exercise testing: Techniques and applications in cardiac disease. Diagnostic considerations in exercise testing: update on new criteria. Risk stratification procedures after an acute coronary event. Heart House Learning Center, American College of Cardiology, June 3-5, 1992.

159. Takase B, Bjerregaard P, Greenwalt T, Kotar S, Janosik D, Fredman C, Prior M, Singh S, Chaitman B. Change of heart rate variability during head-up tilt in patients with neurally mediated syncope. 5th International Congress on Ambulatory Monitoring Meeting, May 13-15, 1992, St. Louis, Missouri.

160. Chaitman BR. Enhancement of Goldman preoperative cardiac risk assessment with the use of intravenous dipyridamole thallium scintigraphy in patients referred for major nonvascular surgery. XIVth Congress of the European Society of Cardiology, presented August 30-September 3, 1992, Barcelona, Spain.

161. Albert S, Gomez C, Russell ST, Chaitman B. Cerebral and opthalmic artery vascular responses associated with blood pressure and exercise in diabetes mellitus. Presented at the American Diabetes Association Meetings, San Antonio, Texas, June 20-23, 1992.

162. Takase B, Younis LT, Labovitz AJ, Stratman H, Byers SL, Chaitman BR, Miller DD. Relative prognostic value of dipyridamole stress myocardial imaging and rest two-dimensional echocardiography in the preoperative stratification of elderly nonvascular surgery patients. XIVth Congress of the European Society of Cardiology, August 30-September 3, 1992, Barcelona, Spain.

163. Wackers FJ, Zaret BL, Chaitman BR, Wasserman A, Thompson B. The prognostic significance of reverse redistribution on thallium-201 stress testing after thrombolytic therapy for acute infarction. J Am Coll Cardiol 1992;19:22A.

164. Younis LT, Takase B, Byers SL, Presti M, Heaney RM, Miller DD, Chaitman BR. Enhancement of Goldman preoperative risk assessment with the use of intravenous dipyridamole thallium scintigraphy in patients referred for major nonvascular surgery. J Am Coll Cardiol 1992;19:156A.

165. Takase B, Younis LT, Labovitz AJ, Byers SL, Caralis DG, Wiens RD, Chaitman BR, Miller DD. Comparative prognostic value of rest two-dimensional echocardiography, dipyridamole stress thallium myocardial imaging and clinical indices for perioperative cardiac events in major nonvascular surgery patients. J Am Coll Cardiol 1992;19:101A.

166. Shaw L, Miller DD, Younis L, Kargl D, Stocke K, Pargulski J, Chaitman B. Is there a post-test gender bias in the management of patients with suspected coronary artery disease referred for noninvasive testing? J Am Coll Cardiol 1992;19:210A.

167. Shaw LJ, Miller DD, Hilton TC, Stocke KS, Stelken AM, Kong BA, Chaitman BR. Preoperative adenosine thallium-201 myocardial perfusion imaging predicts perioperative cardiac events. J Am Coll Cardiol 1992;19:312A.

168. Shaw LJ, Stelken AM, Younis LT, Takase B, Miller DD, Chaitman BR. Optimizing linear metabolic incremental changes during exercise testing: A comparison of four protocols. J Am

Coll Cardiol 1992;19:222A.

169. Younis L, Byers S, Lenzen P, Dahms T, Labovitz A, Chaitman B. Does level carbon monoxide exposure worsen echocardiographic determined left ventricular function at rest and during exercise in patients with ischemic heart disease? J Am Coll Cardiol 1992;19:240A.

170. Hilton TC, Shaw LJ, Stocke KS, Stelken AM, Chaitman BR, Kong BA, Miller DD. Adenosine thallium myocardial perfusion imaging: clinical utility for predicting surgical complications and the need for preoperative revascularization. Circulation 1991;84:II575.

171. Weiner DA, Ryan TJ, Parsons L, Fisher LD, Chaitman BR, Sheffield LT, Tristani FE. Coronary angiography and exercise testing after 5 years among patients with silent ischemia. Circulation 1991;84:II66.

172. Hsia J, Kleiman N, Aguirre F, Chaitman BR, Roberts R, Ross AM. Heparin induced partial thromboplastin time after thrombolysis: prolongation magnitude determines coronary patency. Circulation 1991;84:II-116.

173. Aguirre FV, Mueller H, Kleiman N, McMahon R, Solomon R, Kern MJ, Chaitman BR, TIMI II Investigators. Clinical outcome of young patients with acute myocardial infarction treated with thrombolytic therapy: is a "watchful waiting" strategy appropriate? A TIMI II data bank study. Circulation 1991;84:II-231.

174. Aguirre FV, Kern MJ, Berger PB, McMahon RP, Sopko G, Ross AM, Chaitman BR, and TIMI II investigators. Comparison of left ventricular function and clinical outcome in patients developing Q – wave and non- Q wave myocardial infarction after thrombolysis: TIMI II data bank study. Circulation 1991;84:II-231.

175. Alderman EL, Corley S, Fisher L, Chaitman BR, Faxon D, Foster E, Killip T, Sosa J, Bourassa M. Five year angiographic follow-up of disease progression in the Coronary Artery Surgery Study (CASS). Circulation 1991;84:II-65.

176. Chaitman BR, Froelicher (co-directors). Exercise testing: techniques and applications in cardiac disease. Diagnostic considerations in exercise testing: update on new criteria. Prognostic risk stratification before noncardiac surgery. Heart House Learning Center, American College of Cardiology, June 5-7, 1991.

177. Camp AD, Sullivan NA, Vandeevan EA, Kichura GM, Thoma GE, Chaitman BR. Assessment of ACC exercise test guidelines for screening asymptomatic subjects: experience with police officers. J Am Coll Cardiol 1991;17:236A.

178. Shaw L, Hilton T, Kong B, Stocke K, Younis L, Byers S, Buchanan R, Wiens RD, Caralis DG, Chaitman BR. Dipyridamole thallium imaging for prognosis in elderly patients. J Am Coll Cardiol 1991;17:226A.

179. Teigen G, Kong B, Shaw L, Stocke K, Wiens RD, Caralis DG, Chaitman BR. Comparative side effect profile and safety of intravenous adenosine versus dipyridamole radionuclide imaging. J Am Coll Cardiol 1991;17:79A.

180. Younis LT, Dahms TE, Byers SL, Carroll LM, Wiens RD, Chaitman BR. Does low level carbon monoxide exposure have a proarrhythmic effect in patients with coronary artery disease and ventricular arrhythmia? J Am Coll Cardiol 1991;17:80A.

181. Hilton T, Shaw L, Goodgold H, Wiens R, Caralis D, Stocke K, Chaitman BR. Prognostic value of exercise thallium scintigraphy in elderly patients. J Am Coll Cardiol 1991;17:236A.

182. Chaitman BR, Kern MJ, Taylor HA, Aguirre FV, Sopko G, Ross RN, Bovill EC and TIMI investigators. Does one year outcome after acute myocardial infarction differ with race? Results from the TIMI II trial. J Am Coll

Cardiol 1991;17:246A.

183. Aguirre FV, Serota H, McMahon HA, Aguirre FV, Sopko G, Ross RN, Bovill EC and the TIMI investigators. Prognosis of patients without myocardial necrosis after thrombolytic therapy: a TIMI II data bank study. J Am Coll Cardiol 1991;17:228A.

184. Allam AH, Vita NA, Maniawski PJ, Chaitman B, Zaret BL, Wackers FT. Reverse redistribution of thallium-201 after exercise: prevalence and functional significance. Circulation 1990;82:III-202.

185. Chaitman BR. One-year TIMI II pilot results [letter]. American Heart Journal. 120(6 Pt 1):1486, 1990 Dec.

186. Weiner DA, Ryan TJ, Fisher LD, Parsons L, Chaitman BR, Sheffield LT, Tristani FE. The significance of silent ischemia in diabetic patients. Circulation 1990;82:III-252.

187. Fagan LF Jr, Chaitman BR, Shaw L, Kong BA, Wiens RD. Prognostic value of exercise thallium scintigraphy in patients with good exercise tolerance and a normal exercise electrocardiogram. Circulation 1990;82:III-357.

188. Hsia J, Kleiman NS, Aguirre F, Roberts R, Chaitman B, Ross AM. Angiographic predictors of reocclusion following initially successful thrombolysis. Circulation 1990;82:III-255.

189. Kong BA, Shaw LJ, Goodgold HM, Chaitman BR. Dipyridamole thallium testing in females. J Nucl Med 1990;31:733.

190. Chaitman BR, Froelicher V (co-directors). Exercise testing: techniques and applications in cardiac disease. Exercise testing post-myocardial infarction with and without thrombolysis and after intervention. Exercise testing in clinical patient subsets. Heart House Learning Center, American College of Cardiology, June 7-9, 1990.

191. Ross AM, Hsia J, Hamilton W, Chaitman B, Roberts R, Kleiman NS. Heparin versus aspirin after recombinant tissue plasminogen activator therapy in myocardial infarction: a randomized trial. J Am Coll Cardiol 1990;15:64A.

192. Weiner DA, Ryan TJ, Parsons L, Fisher LD, Chaitman BR, Sheffield LT, Tristani FE. The prevalence and prognostic significance of silent myocardial ischemia after coronary bypass surgery. J Am Coll Cardiol 1990;15:119A.

193. Wiens RD, Caralis DG, Wiens G, Shaw L, Haueisen M, Younis L, Chaitman BR. Interphysician versus computer-assisted interpretation of exercise electrocardiograms. J Am Coll Cardiol 1990;15:263A.

194. Haueisen M, Shaw L, Bilgere B, Younis L, Stocke K, Wiens RD, Caralis D, Chaitman BR. Application of computerized exercise electrocardiogram digitization interpretation in large clinical trials. J Am Coll Cardiol 1990;15:259A.

195. Chaitman BR, Younis LT, Shaw LJ, Wiener DA, Bryant M, Knatterud GL, Sopko G, Braunwald E, and TIMI investigators. Exercise ECG test results in the TIMI II trial. J Am Coll Cardiol 1990;15:251A.

196. Kong B, Chaitman BR. Exercise testing after coronary angioplasty. Cardio Magazine, 1990 (April):89.

197. Shaw LJ, Younis LT, Stocke KS, Sharma AK, Chaitman BR. Does posture influence metabolic and hemodynamic exercise variables post myocardial infarction? Circulation 1989;80:II-609.

198. Younis LT, Carraci BF, Dowell S, Aguirre FV, Byers SL, Barth G, Peterson GJ, Chaitman BR. Two year prognosis after IV dipyridamole thallium imaging in patients with peripheral vascular disease. Circulation 1989;80:II-226.

199. Labovitz A, Tatineni S, Pearson A, Kelly K, Ojile M, Barner H, Chaitman. Exercise

evaluation of prosthetic heart valves. European Heart J 1989;10:424.

200. Younis L, Dowell S, Byers S, Chaitman B. Long-term prognosis in peripheral vascular disease patients. A dipyridamole-thallium imaging study. European Heart J 1989;10:161.

201. Shaw L, Younis L, Stocke K, Sharma A, Chaitman B. Does posture influence predischarge exercise risk stratification post myocardial infarction? European Heart J 1989;10:129.

202. Chaitman B, Younis L, Goodgold H. Prognosis of silent myocardial ischemia detected by intravenous dipyridamole thallium imaging. European Heart J 1080;10:31.

203. Tatineni S, Labovitz AJ, Pearson AC, Kelly K, Ojile M, Barner HM, Chaitman BR. Exercise evaluation of prosthetic heart valve: importance of valve size and left ventricular function. American Federation for Clinical Research National Meeting, Washington, D.C., April 29, 1989.

204. Camp A, Hartse K, Shaw L, Chaitman B. Nasal continuous positive airway pressure during sleep decreases waking airflow obstruction in non-smoking patients with severe obstructive sleep apnea. 70th annual session of the American College of Physicians Meeting. San Francisco, California, April 13-16, 1989.

205. Camp A, Hoff J, Shaw L, Byers S, Garvin P, Chaitman B. The role of intravenous dipyridamole thallium imaging in preoperative cardiac risk assessment before renal transplantation. J Am Coll Cardiol 1989;13:161A.

206. Younis LT, Byers S, Shaw L, Barth G, Goodgold H, Wiens RD, Chaitman. Prognostic value of intravenous dipyridamole thallium imaging in asymptomatic patients with coronary disease and no previous myocardial infarction. J Am Coll Cardiol 1989;13:126A.

207. Gottlieb SO, Allred EN, Bleecker ER, Chaitman BR, Dahms T, Hackney JD, Pagano M, Selvester RH, Walden SM, Warren J. Urban angina – low levels of carbon monoxide exacerbate myocardial ischemia: a multicenter, randomized controlled trial. Circulation 1988;78:II-257.

208. Weiner DA, Ryan TJ, McCabe CH, Ng G, Fisher LD, Chaitman BR. The role of exercise induced silent myocardial ischemia in patients with abnormal left ventricular function. Circulation 1988;78:II-25 (suppl).

209. Chaitman BR, Ryan TJ, Kronmal RA, Foster E, Frommer PL, Killip T, and CASS investigators. Comparability of the CASS randomized and randomizable populations ten years following enrollment. Circulation 1988;78:III-637 (suppl).

210. Chaitman BR, Knatterud GL, Stump D, Hamilton WP, Hillis LD, Dwyer JG, Solomon RE, and TIMI investigators. Thrombolytic therapy for acute myocardial infarction in the elderly. Circulation 1988;78:II-211(suppl).

211. Chaitman BR, Thompson BW, Solomon RE, Cohen M, Ruocco NA, Kern MJ, Vandormael MG, and TIMI investigators. The TIMI phase II pilot study: one year results. Circulation 1988;78:II-501(suppl).

212. Deligonul U, Vandormael M, Kern M, Gabliani G, Shah Y, Bodet J, Galan K, Chaitman B. Follow-up after coronary angioplasty for restenosis: time interval between the initial and second procedures is predictive of follow-up events. European Heart J 1988;9:57.

213. Chaitman B, Allred E, Bleecker E, Dahms T, Gottlieb S, Hackney J, Pagano M, Selevester R, Walden S, Warren J, and the HEI CO multicenter study team. Do low levels of carbon monoxide exposure potentiate myocardial ischemia? European Heart J 1988;9:27.

214. Chaitman BR (program director). Exercise testing: techniques and applications in cardiac disease. Exercise ECG lead systems and new diagnostic criteria. Heart House Learning Center, American College of Cardiology, Bethesda, Maryland, June 9-11, 1988.

215. Chaitman BR (program director). Exercise testing: techniques and applications in cardiac disease. Noninvasive risk stratification post myocardial infarction in the thrombolytic era-what have we learned? Exercise evaluation of coronary angioplasty patients: assessment and prognosis. Heart House Learning Center, American College of Cardiology, Bethesda, Maryland, June 12-14, 1987.

216. White CW, Chaitman B, Schmidt D, Marcus ML, Armstrong P, Knudson M, Morton B, Roy L, Khaja F, Reitman M, and the Ticlopidine Study investigators. Antiplatelet agents are effective in reducing the immediate complications of PTCA: results from the Ticlopidine Multicenter Trial. Circulation 1987;76:IV-400.

217. Weiner DA, Ryan TJ, McCabe CH, Ng G, Fisher LD, Chaitman BR, Sheffield LT, Tristani FE. The incidence of myocardial infarction and sudden death in patients with exercise-induced silent myocardial ischemia (CASS). Circulation 1987;76:IV-78.

218. Labovitz AJ, Pearson AC, Mrosek D, Chaitman BR. Doppler echocardiographic evaluation of response to intravenous dipyridamole. Circulation 1987;76:IV-225.

219. Lam J, Chaitman BR, Byers S, Bowles J, Wiens RD, Goodgold H, Samuels L. Can dipyridamole thallium imaging predict restenosis after coronary angioplasty? Circulation 1987;76:IV-373.

220. Chaitman BR, Deligonul U, Kern MJ, Vandormael MG. Prognostic importance of silent myocardial ischemia after coronary angioplasty. Circulation 1987;76:IV-78.

221. Lam JYT, Chaitman BR, Byers S, Bowles J, Glaenzer M, Goodgold H, Samuels L, Kern MJ, Vandormael MG. Noninvasive assessment of coronary reserve before and after coronary angioplasty using dipyridamole thallium imaging. Cardiology and Cardiovascular Surgery: Interventions 1987. Annual Symposium celebrating the 25th Anniversary of the Texas Heart Institute. Houston, Texas, October 7-10, 1987.

222. Vandormael M, Deligonul U, Kern M, Gabliani G, Zelman R, Bodet J, Chaitman B. Does extent of PTCA revascularization influence late outcome in patients with two and three-vessel disease. Fifth Joint Meeting of the European Society of Cardiology and Symposium on Ten Years Balloon Dilatation in Cardiovascular Disease, Santiago de Composteal, Spain, September 5-10, 1987.

223. Deligonul U, Vandormael M, Kern M, Gabliani G, Zelman R, Bodet J, Chaitman B. Coronary angioplasty in multivessel disease: incidence of angiographic restenosis. Fifth Joint Meeting of the European Society of Cardiology and Symposium on Ten Years Balloon Dilatation in Cardiovascular Disease, Santiago de Composteal, Spain, September 5-10, 1987.

224. Chaitman BR, Vandormael M, Byers S, Deligonul U, Shah Y, Kern M. Detection of restenosis following coronary angioplasty using IV dipyridamole thallium imaging. Fifth Joint Meeting of the European Society of Cardiology and Symposium on Ten Years Balloon Dilatation in Cardiovascular Disease, Santiago de Composteal, Spain, September 5-10, 1987.

225. Chaitman BR (program director). Exercise testing: Clinical applications in coronary heart disease. Influence of drugs and revascularization procedures on the exercise test response; evaluation of the suspected or proven coronary patient who cannot exercise; IV dipyridamole thallium imaging and other techniques. American College of Cardiology Heart House, Bethesda, Maryland, June 1-3,

1987.

226. Goodgold HM, Shah Y, Samuels LD, Chaitman BR. Improved criteria for interpretation of quantitative dipyridamole thallium studies. J Nuclear Medicine 1987;28:580.

227. Chaitman BR, Ludbrook P (directors). The initial 6 hours of acute myocardial infarction; TIMI Phase IIB. St. Louis and Washington Universities, St. Louis, Missouri, May 21, 1987.

228. Chaitman BR. Update on NIH trial of thrombolytics in myocardial infarction (TIMI). The 59th Annual Scientific Session of the New York Cardiology Society, April 25, 1987.

229. Stoddard MF, Labovitz AJ, Byers S, Chaitman BR. Doppler-echocardiographic assessment of diastolic and systolic properties of Ibopamine. Clin Res 1987;35:329A.

230. Weiner DA, Ryan TJ, McCabe CH, Luk S, Chaitman BR, Sheffield LT, Tristani FE, Fisher LD. Medical versus surgical therapy in patients with silent myocardial ischemia during exercise testing. J Am Coll Cardiol 1987;9:59A.

231. Shah Y, Chaitman BR, Deligonul U, Kern M, Byers S, Vandormael M. The prognostic role of exercise testing early after coronary angioplasty for multivessel disease. J Am Coll Cardiol 1987;9:194A.

232. Weiner DA, Ryan TJ, McCabe CH, Luk S, Chaitman BR, Sheffield LT, Tristani FE. The significance of silent myocardial ischemia during exercise testing. Circulation 1986;74:II-502.

233. Galan KM, Deligonul U, Kern MJ, Chaitman BR, Vandormael MG. Smoking increases the risk of restenosis following coronary angioplasty. Circulation 1986;74:II-281.

234. Deligonul U, Vandormael M, Harper M, Kern M, Presant S, Chaitman B. PTCA in the management of patients with new onset angina: immediate and long-term outcome. Xth World Congress of Cardiology, Washington, D.C., September 14-19, 1986.

235. Vandormael M, Deligonul U, Harper M, Kern M, Presant S, Galan K, Chaitman B. Coronary angioplasty in multivessel coronary disease: clinical and angiographic results. International Symposium on Interventional Cardiology, Texas Heart Institute, September 21-23, 1986.

236. Buckingham T, Thessen C, Ghosh S, Janosik D, Chaitman B, Wiens R. Conduction defects do not preclude the usefulness of late potentials in identifying patients with sustained ventricular tachycardia. 13th International Congress on Electrocardiology, 27th International Symposium on Vectorcardiogrpahy, Washington, D.C., September 10-12, 1986.

237. Vandormael M, Deligonul U, Harper M, Kern M, Mehdirad A, Chaitman B. Clinical and angiographic follow-up after PTCA in patients with three-vessel coronary disease. Xth World Congress of Cardiology, Washington, D.C. September 14-19, 1986.

238. Deligonul U, Vandormael M, Harper M, Kern M, Chaitman B, Kennedy H. Immediate and long-term results of PTCA in severe post myocardial infarction angina. Xth World Congress of Cardiology, September 14-19, 1986, Washington, D.C. Eur Heart J

239. Chaitman BR (program director). Exercise testing: techniques and clinical applications in coronary heart disease. Serial exercise testing: what is a signficant change? The changing role of predischarge noninvasive risk stratification after aggressive management of myocardial infarction (thrombolysis, PTCA). American College of Cardiology Heart House, Washington, D.C., June 5-7, 1986.

240. Buckingham TA, Shosh S, Redd M, Chaitman BR, Stevens L, Kennedy HL. Do late potentials predict sustained ventricular tachycardia independent or left ventricular function in patients with coronary artery

disease? J Am Coll Cardiol 1986;7:104A.

241. Vandormael M, Deligonul U, Mehdirad A, Harper M, Chaitman BR. Late angiographic outcome following successful multivessel lesion PTCA. J Am Coll Cardiol 1986;7:62A.

242. Chaitman BR, Davis KB, Dodge HT, Fisher LD, Kaiser GC, and CASS Hospitals. Should airline pilots fly following coronary bypass surgery? A CASS Registry study. J Am Coll Cardiol 1986;7:142A.

243. Mehdirad AA, Williams GA, Bryg RJ, Windhorst D, Habermehl K, Chaitman BR. Evaluation of left ventricular function with upright exercise: correlation of exercise Doppler with post-exercise wall motion and single plane echocardiographic ejection fraction.
Circulation 1985;72:III-449.

244. Gibson PH, Holten D, Smith SC, Chaitman BR, Kennedy HL. Absence of thermal tissue injury using a pulse mode Nd-Yag laser. Circulation 1985;72:III-402.

245. Hernandez J, Vandormael MG, Harper JM, Deligonul U, Chaitman BR. PTCA in multivessel coronary disease: influence of degree of revascularization. Circulation 1985;72:III-139.

246. Weiner DA, Ryan TJ, McCabe CH, Fisher LD, Chaitman BR, Sheffield LT, Tristani RD. Value of exercise testing in three-vessel coronary disease (CASS Registery). Circulation 1985;72:III-463.

247. Chaitman BR, Davis KB, Kaiser GC, Mudd G, Wiens RD, and participating CASS hospitals. Combined proximal left anterior descending and proximal left circumflex disease. Prognostic influence of coronary bypass surgery (CASS Registry). Circulation 1985;72:III-291.

248. Deumite NJ, Chaitman BR, Davis KB, Killip T, Frommer PL, Rogers WJ. Asymptomatic left main coronary artery disease (CASS). J Am Coll Cardiol 195;5:518.

249. Waters DD, Lam J, Crean P, Chaitman BR. Is Nisoldipine a better antianginal drug than nifedipine? 38th Annual Meeting of the Canadian Cardiovascular Society, Halifax, Nova Scotia, October 23-26, 1985.

250. Chaitman BR (guest speaker). Role of revascularization post myocardial infarction. 118th Annual Scientific Sessions of the Canadian Medical Association, Ottawa, August 18-23, 1985.

251. Chaitman BR (program director). Exercise cardiomyopathy: technique and diagnostic applications. Diagnostic stress test techniques-sequence of utilization. Diagnostic procedures in the patient who can't exercise. Test choices for risk stratification early after myocardial infarction. Exercise evaluation of revascularization procedures; CABG, PTCA. Influence of drugs on exercise test responses. Exercise radionuclide procedures are of value in the assessment of ischemic heart disease. Clinical Applications of Stress Testing Techniques in Coronary Disease. American College of Cardiology Heart House, Washington, D.C., May 20-22, 1985.

252. Vandormael MG, Chaitman BR, Aker UT, Ischinger T, Harper JM, Hernandez J, Deligonul U, Kennedy HL. Immediate and shor-term benefit of multilesion coronary angioplasty: influence of degree of revascularization. Eur Heart J 1985;6:60.

253. Chaitman BR, Davis K, Kaiser GC, Wiens RD, Mock MB, Bourassa MG, Passamani E, Killip t, Mudd JG, and participating CASS Hospitals. The prognostic spectrum of "left main equivalent coronary disease". Eur Heart J 1985;6:58.

254. Williams GA, Labovitz AJ, Bryg RJ, Byers SL, Windhorst DM, Chaitman BR. Change in cardiac output with exercise in patients with and without CAD as measured by Doppler echocardiography. Am Fed Clin Res

1985;33:238A.

255. Williams GA, Labovitz AJ, Bryg RJ, Byers SL, Windhorst DM, Chaitman BR. Change in cardiac output with exercise in patients with CAD as measured by Doppler echocardiography. Clin Res 1985;33:238A.

256. Chaitman BR, Hung J, Lam J, Lesperance J, Dupras G, Fines P, Robert P, Bourassa MG. Cardiac fluoroscopy, exercise electrocardiography and thallium scintigraphy in the diagnostic evaluation of presence and severity of coronary disease in men. J Am Coll Cardiol 1984;3:519.

257. Bryg RJ, Labovitz AJ, Byers SL, Windhorst DM, Williams GA, Chaitman BR. Doppler exercise treadmill: assessment of cardiac function. Clin Res 1984;32:728A.

258. Geish BJ, Schaff HV, Fisher LD, Frye RL, Mock MB, Ryan TJ, Ellise RB, Chaitman BR, Alderman EL, Kaiser GC, Faxon DP, Bourassa MG and participants in the CASS study. Effect of perioperative myocardial infarction on late survival after coronary artery bypass surgery on patients in the CASS registry. Circulation 1984;70:II-322.

259. Vandormael MG, Ischinger T, Russ T, Aker UT, Chaitman BR, Kennedy HL. Complex coronary angioplasty: immediate and six month functional results. Circulation 1984;70:II-322.

260. Tristani RE, Chaitman BR, Fisher LD, Weiner DA, McCabe CH, Sheffield LT, Ryan TJ, and participating CASS sites. Exercise test responses in angiographic high risk coronary artery disease (CASS Registry). Circulation 1984;70:II-61.

261. Weiner DA, McCabe CH, Rayn TJ, Fisher LD, Chaitman BR, Sheffield LT, Tristani F. Value of exercise testing in identifying patients with improved survival after coronary bypass surgery (CASS Registry). Circulation 1984;70:II-20.

262. Lam J, Chaitman BR, Crean P, Waters DD. A randomized placebo-controlled, double-blind study of three dose levels of a new calcium antagonist, nisoldipine, in patients with stable angina. 1984 Annual Meeting, Canadian Cardiovascular Society, Quebec City, Quebec, October 17-20, 1984.

263. Lam J, Chaitman BR, Benjamin J, Roy D, Waters DD. Comparative efficacy of tocanide and disopyramide in chronic ventricular arrhythmias. 1984 Annual Meeting, Canadian Cardiovascular Society, Quebec City, Quebec, October 17-20, 1984.

264. Sami M, Chaitman BR, Fischer LD, Holmes D, Fray D, Alderman E. Long-term prognostic significance of exercise-induced ventricular arrhythmia in patients with stable coronary artery disease (CASS study project). 1984 Annual Meeting, Canadian Cardiovascular Society, Quebec City, Quebec, October 17-20, 1984.

265. Chaitman BR (program director). Predischarge risk stratification post myocardial infarction. Acute myocardial infarction: early intervention and management. St. Louis, MO September 13, 1984.

266. Chaitman BR. Bioprosthesis vs. mechanical devices. Second International Symposium on Advances in Cardiovascular Therapy. Barcelona, Spain, October 10-12, 1984.

267. Chaitman BR. Nuclear cardiology in the diagnosis and management of coronary artery disease. Clinical Cardiology, 1984 update. St. Louis University School of Medicine, St. Louis, Missouri, April 13-14, 1984.

268. Chaitman BR. Optimal lead systems, stress protocols, ST criteria for treadmill exercise testing: CASS experience with stress testing, Bayesian Theory: Cardiomyopathy, exercise testing in vasospastic angina. Clinical applications of stress testing techniques in coronary heart disease. American College of Cardiology Heart House, Washington, D.C.,

May 7-9, 1984.

269. Hung J, Chaitman BR, Lam J, Lesperance J, Dupras G, Fines P, Bourass MG. Noninvasive diagnostic test choices for the evaluation of coronary heart disease in women: a multivariate comparison of cardiac fluoroscopy, exercise electrocardiography and exercise Thallium perfusion scintigraphy. J Am Coll Cardiol 1984;3:519.

270. Chaitman BR (moderator), Ebert PA, Kunkel B, Santamore WP, Schaff HV, Kaiser G. To what extent should poor LV function inhibit coronary and valvular surgery. 33rd Annual Scientific Sessions of the American College of Cardiology, Dallas, Texas, March 26-29, 1984.

271. Weiner DA, McCabe CH, Ryan TJ, Ferguson J, Chaitman BR, Sheffield LT, Fisher LD. The value of preoperative exercise testing in determining survival after coronary bypass surgery (CASS). Circulation 1983;68:III-375.

272. David PR, Chaitman BR, Lesperance J, Renkin J, Bourassa MG. Progression of single-vessel disease to complete occlusion: an uncommon cause of myocardial infarction. Circulation 1983;68:III-29.

273. Pomar JL, Garcia-Dorado D, Bosch X, Pelletier C, Chaitman BR. Significance of diastolic aortic murmurs after aortic valve replacement. Circulation 1983;68:III-342.

274. Moise A, Bosch X, Theroux P, Pelletier GB, Roy D, Waters DD, Chaitman BR, David PR, Dyrda I. Angiographic correlates of early spontaneous ischemia after acute myocardial infarction. Circulation 1983;68:III-315.

275. Bosch X, Moise A, Chaitman BR, Theroux, Lesperance J. Limited treadmill exercise testing (GXT) after acute myocardial infarction (MI) in patients with and without previous MI. Circulation 1983;68:III-376.

276. Chaitman BR, CASS Principal Investigators and their associates. Myocardial infarction rates in the CASS randomized trial. Circulation 1983;68:III-293.

277. Hung J, Chaitman BR, Lam J, Lesperance J, Dupras G. Is cardiac fluoroscopy or thallium scintigraphy a better diagnostic test for coronary disease than exercise electrocardiography in women? Annual Scientific Sessions of the Canadian Cardiovascular Society, Toronto, Canada, October 19-21, 1983.

278. Hung J, Chaitman BR, Lam J, Lesperance J, Dupras G, Fines P, Cherkaoui O, Robert P, Bourassa MG. A noninvasive approach to the detection of high risk coronary disease in men. Annual Scientific Sessions of the Canadia Cardiovascular Society, Toronto, Canada, October 19-21, 1983.

279. Lam J, Hanson JS, Chaitman BR, Lesperance J, Hung J. Montreal and Burlington. Does exercise polarcardiography increase the diagnostic yield of the 14 lead maximal exercise test? Annual Scientific Sessions of the Canadian Cardiovascular Society, Toronto, Canada, October 19-21, 1983.

280. Chaitman BR. Uses and limitations of exercise testing in the evaluation of patients with ischemic heart disease. 7th Biennial Course. Advances in Internal Medicine, University of Alberta Medical School, Banff, Alberta, June 13-17, 1983.

281. Chaitman BR. Beta blockers in myocardial infarction. Current concepts. 7th Biennial Course. Advances in Internal Medicine, University of Alberta Medical School, Banff, Alberta, June 13-17, 1983.

282. Chaitman BR. An interim report from the Coronary Artery Surgery Study (CASS). Dutch Interuniversity Cardiology Institute, Symposium on long term results of coronary bypass graft surgery, Rotterdam, Holland, June 3, 1983.

283. Chaitman BR. Interpretation of the exercise ECG. 1983 Annual Scientific Sessions of the

American College of Sports Medicine, Montreal, Quebec, May 18-27, 1983.

284. Chaitman BR. Exercise testing-indications and usefulness. Cardiology in Family Practice. Practical answers to problems in primary care. 9th Annual Meeting, McGill University, Montreal, Quebec, April 22, 1983.

285. Miller DD, Garcia-Dorado D, Garcia EJ, Delcan JL, Maroto E, Chaitman BR. Pulmonary hypertension following acute syndrome toxico due to toxic rapeseed oil exposure. The 64th Annual Session of the American College of Physicians, San Francisco, California, April 11-14, 1983.

286. Wagniart P, Chaitman BR, Brevers G, Ferguson RJ, Pasternac A, Bourassa MG. Comparison of nifedipine and diltiazem on exercise tolerance in chronic stable angina pectoris. J Am Coll Cardiol 1983;

287. Pomar JL, Garcia-Dorado D, Almazan A, Betriu A, Chaitman BR, Pelletier C. Determinants of clinical status following valve replacement for pure aortic regurgitation. J Am Coll Cardiol 1983;

288. Chaitman BR. Medical-surgical options in single-vessel coronary disease. Annual Scientific Sessions of the Belgium Cardiac Society, Brussels, Belgium, March 12-13, 1983.

289. Chaitman BR. How to perform and interpret an exercise test. 5th Annual Tutorial in Cardiology, University of Vermont, Sugarbush Inn, Vermont, February 28-March 4, 1982.

290. Capos N, Alderman E, Luk S, Oberman A, Holmes D, Fisher LD, Chaitman BR, Sheffield T. Clinical and angio antecendents of MI-CASS. Circulation 1982;66:II-371.

291. Weiner DA, McCabe CH, Ryan TJ, Chaitman BR, Sheffield LT, Ferguson RJ, Fisher LD. Combining treadmill time and ST segment response during exercise testing to predict survival of coronary patients (CASS). Circulation 1982;66:II-341.

292. Brevers G, Chaitman BR, Scholl JM, Dupras G, Lesperance J, Bourass MG. Thallium scintigraphy or cardiac fluoroscopy when the exercise ECG is strongly positive. Circulation 1982;66:II-341.

293. Chaitman BR, Alderman EL, Sheffield LT, Tong T, Fisher LD, Mock MB, Wiens RD, Bourassa MG, Kaiser G, Gersh B, Schaff H, Killip T, and participating CASS hospitals. Use of survival analysis to determine the significance of new postoperative Q waves following coronary bypass surgery (CASS). Circulation 1982;66:II-92.

294. Chaitman BR, Davis K, Bourassa MG, Fisher LD, Fray D, Rogers WJ, Tyras DH, Mock MB, Killip T and participating CASS hospitals. Prognostic importance of left main nonequivalent coronary disease (CASS). Circulation 1982;66:II-10.

295. Bonan R, Taeymans Y, Pelletier C, Dyrda I, Chaitman BR. Instant impedance charcteristics of aortic valve devices evaluated in vivo. A new index of valve performance. Annual Scientific Sessions of the Canadian Cardiovascular Society, Calgary, Alberta, October 20-22, 1982.

296. Chaitman BR (moderator), McLaughlin P, Freeman M. The exercise evaluation of ischemic heart disease. Annual Scientific Sessions of the Canadian Cardiovascular Society, Calgary, Alberta, October 20-22, 1982.

297. Wagniart P, Chaitman BR, Brevers G, Fergusion RJ, Pasternac A, Bourassa MG. Comparison of nifedipine and diltiazem on exercise tolerance in chronic stable angina pectoris. Annual Scientific Sessions of the Canadian Cardiovascular Society, Calgary, Alberta, October 20-22, 1982.

298. Chaitman BR. Long-term (10 year) results following coronary bypass surgery. Civil Aviation Medical Association. 17th Annual

Symposium, Toronto, Canada, September 12-17, 1982.

299. Chaitman BR. Diagnostic test choices in the assessment of coronary disease. Civil Aviation Medical Association. 17th Annual Symposium, Toronto, Canada, September 12-17, 1982.

300. Chaitman BR, Betriu A, Almazan A, Guiteras Val, Pelletier C. Determinants of return to sinus rhythm after valve replacement. International Symposium on Cardiac Bioprosthese, Rome, Italy, May 17-19, 1982.

301. Pelletier C, Chaitman BR, Bonan R, Dyrda I. Postoperative hemodynamic evaluation of the Carpentier-Edwards standard and improved annulus bioprostheses. International Symposium on Cardiac Bioprosthesese, Rome, Italy, May 17-19, 1982.

302. Chaitman BR. Importancia pronostica de los supuesto "equivalentes de tronco". Premier reunion internatinale de Cardiologie de l'Hopital Provincial de Madrid, Madrid, Espagne, Mai 13-14, 1982.

303. Chaitman BR. Interpretation des E.C.G. par ordinateur: apport et limites. Premier reunion internatinale de Cardiologie de l'Hopital Provincial de Madrid, Madrid, Espagne, Mai 13-14, 1982.

304. Chaitman BR. E.C.G. l'effort. Cardiologie du Praticien, Unviersite de Montreal, Montreal, Quebec, Mai 6, 1982.

305. Mock MB, Ringqvist I, Fischer L, Davis K, Chaitman BR, Russel R, Mullin S, Killip T, Fray D. The survival of nonoperated patients with ischemic heart disease: the CASS experience. Am J Cardiol 1982;49:1007.

306. Betrium A, Chaitman BR, Brevers G,School JM, Brunea P, Gagne P, Chabot M, Bourassa MG. Beneficial effect of intravenous diltiazem in the acute management of paroxysmal supraventricular tachyarrhythmias. Am J Cardiol 1982;49:977.

307. Wagniart P, Chaitman BR, Ferguson RJ, Brevers G, Scholl JM, Clozel JP, Pasternac A, Bourassa MG. Duration on improved exercise performance following oral diltiazem in chronic stable angina. Am J Cardiol 1982;49:2000.

308. Chaitman BR. Exercise induced coronary spasm and ST elevation. American College of Cardiology. Mini-course on exercise testing, Atlanta, Georgia, April 25, 1982.

309. Chaitman BR. Exercise testing: diagnostic and physiologic considerations (lead systems, coronary spasm post-infarct exercise testing). American College of Cardiology Heart House, Bethesda, Maryland, April 5-7, 1982.

310. Chaitman BR. Exercise stress testing: today and tomorrow. (lead systems; ST elevation) Long Beach, California, March 12, 1982.

311. Chaitman BR. Comparison of nifedipine and propranolol on exercise tolerance in chronic stable angina pectoris. The First Canadian Adalat Symposium, Montreal, Quebec, February 11, 1982.

312. Pelletier C, Baillot R, Guiteras Val P, Chaitman BR, Bonan R, Dyrda I. Clinical and hemodynamic results with the Carpentier-Edwards porcine valve prostheses. Society of Thoracic Surgeons, New Orleans, Louisiana, February 1982.

313. Delcan JL, Chaitman BR, Lopez-Bascos L, Garcia-Dorado D, Rivera R. Hemodynamic performance of the Angell-Shiley porcine heterograft. Eur Heart J 1981;2:148.

314. Chaitman BR (moderator), Killip T, Alderman E, Sheffield LT. How to assess perioperative myocardial infarction. American Heart Association, Dallas, Texas, November 16-19, 1981.

315. McCabe CH, Ryan TJ, Weiner DA, Fisher LD, Chaitman BR, Sheffield LT, Ferguson RJ. The

value of exercise testing in determining survival in patients with defined coronary anatomy (CASS). Circulation 1981;64:IV-12.

316. Waters DD, Szlachic J, Bourassa MG, Scholl JM, Chaitman BR, Theroux P. Exercise testing in variant angina results, clinical correlation and prognostic value. Circulation 1981;64:IV-12.

317. Guiteras Val P, Chaitman BR, Scholl JM, Waters DD, Bourassa MG, Ferguson RJ, Wagniart P. Diagnostic accuracy of exercise lead systems in clinical subsets of women. Circulation 1981;64:IV-186.

318. Scholl JM, Chaitman BR, David PR, Dupras G, Bernard P, Bourassa MG. Evaluation of percutaneous transluminal coronary angioplasty by noninvasive techniques. Circulation 1981;64:IV-253.

319. Scholl JM, David PR, Chaitman BR, David PR, Dupras G, Bernard P, Bourassa MG. Recurrence of stenosis following percutaneous transluminal coronary angioplasty. Circulation 1981;64:IV-193.

320. Chaitman BR, Waters DD, Szlachcic J, Theroux P. Is it necessary to follow indefinitely medical treatment in vasospastic angina? International Symposium on the Medical Treatment of Angina Pectoris. Cannes, France, October 2-3, 1981.

321. Wagniart P, Ferguson RJ, Chaitman BR, Achard F, Benacerraf A, Morin B, Pasternac A, Bourassa MG. Oral diltiazem (120 mg) increases exercise tolerance and delays onset of ECG ischemia in patients with coronary artery disease. Canadian Cardiovascular Society, Montreal, Quebec, October 28-31, 1981.

322. Mercier LA, Guiteras Val P, Gagnon G, Chaitman BR. M-mode echocardiography: diagnostic relevance to clinical practice in 1981. Canadian Cardiovascular Society, Montreal, Quebec, October 28-31, 1981.

323. David PR, Scholl JM, Waters DD, Szlachcic J, Bourassa MG, Dupras G, Chaitman BR, Theroux P. Evaluation des resultats de la dilatation cornarienne percutanee par les epreuve d'effort non-invasives. International Symposium on Noninvasive Methods in Ischemic Heart Disease, Nancy, France, September 21-22, 1981.

324. Scholl JM, Waters DD, Szlachcic J, Bourassa MG, Dupras G, Chaitman BR, Theroux P. Epreuve d'effort et scintigraphie du myocarde au thallium-201 a l'effort dans l'anger de Prinzemtal. International Symposium on Noninvasive Methods in Ischemic Heart Disease, Nancy, France, September 21-22, 1981.

325. Scholl JM, Chaitman BR, Guiteras Val P, Dupras G, Bourassa MG. Valeur de la scintigraphie du myocarde au thallium-201 a l'effort chez la femme symptomatique. International Symposium on Noninvasive Methods in Ischemic Heart Disease, Nancy, France, September 21-22, 1981.

326. Zimmern SH, Rogers WJ, Bream PR, Chaitman BR, Bourassa MG, Davis KA, Tyras DH, Berger R, Fisher L, Judkins MP, Mock MB, Killip T. Total occlusion of the left main coronary artery: the CASS experience. Am J Cardiol 1981;47:408.

327. Chaitman BR. Lead systems in exercise testing. Coronary spasm. American College of Cardiology, Mini-course on exercise testing. San Francisco, California, March 15, 1981.

328. Chaitman BR. Long-term continuing follow-up, assessment, and management of patients after valvular surgery. B.C. Heart Foundation 24th Annual Cardiac Symposium, Vancouver, B.C., February 6, 1981.

329. Chaitman BR. Invasive and noninvasive tests to determine the optimal timing of aortic valve replacement. B.C. Heart Foundation 24th Annual Cardiac Symposium, Vancouver, B.C.,

February 6, 1981.

330. Chaitman BR, Rogers WJ, Davis K, Tyras DH, Berger R, Bourassa MG, Fisher L, Judkins MP, Mock MB, Killip III T. Clinical factors relating to high risk coronary disease in CASS. Circulation 1980;62:III-214.

331. Pelletier C, Martin-Albo C, Chaitman BR, Herbert Y, Castonguay Y. Le replacement valvulaire chez le patient age. Journees Chirurgicales Scientifiques de L'universite de Montreal, November 21-22, 1980.

332. Chaitman BR, Rogers WJ, Fisher L, Tyras DH, Berger RL, Bourassa MG, Davis K, Judkins MP, Mock MB, Ringqvist I, Killip T. Survival patterns in left main coronary disease subsets: results of the CASS study. Circulation 1980;62:III-249.

333. Chaitman BR. Clinical and hemodynamic evaluation of the Carpentier-Edwards bioprosthesis. Symposium sur la Chirurgie Cardiaque. Hopital Notre-Dame, Montreal, October 31, 1980.

334. Chaitman BR. Epreuve d'effort: indications et limites. Journee Medicales Prosst, St-Hyacinthe, 24 Octobre 1980.

335. Chaitman BR, Bourassa MG, Goulet C, Grondin C, Lespersance J. Identification et therapie suggeree pour le patient avec stenose due tronc commun et revue de l'experience du C.A.S.S. Journee Scientifique de l'Hospice Civil de Lyon. Lyon France 24 Septembre 1980.

336. Chaitman BR, Bourassa MG. What is the predictive value of noninvasive tests in detecting coronary artery disease in a pilot. XXVIII International Congress of Aviation and Space Medicine. Montreal, Quebec, September 8-11, 1980.

337. Chaitman BR. Spasm in response to exercise and exercise-induced ST elevation. Future directions in exercise testing and exercise electrocardiography. American College of Cardiology Heart House Learning Center, Washington, D.C., July 25, 1980.

338. Chaitman BR. Comparison of currently used lead system (sensitivity and specificity). Future directions in exercise testing and exercise electrocardiography. American College of Cardiology Heart House Learning Center, July 25, 1980, Washington, D.C.

339. Chaitman BR. Nouvelles methodes dans le diagnostic de la maladie coronarienne. Actualites Cardiologiques. Institut de Cardiologie de Montreal, Montreal. Juin 12-13, 1980.

340. Chaitman BR, Delcan JL, Bonan R, Rivera R, Tubau JF, Lopez-Bescoes L, Vallejo VF, Lepage G. Comparative hemodynamic evaluation of the Carpentier-Edwards and Angell-Shiley porcine xenografts. American College of Cardiology, March 13, 1980.

341. Tubau JF, Bourassa MG, Chaitman BR, Waters DD, Lesperance. Influence of coronary collaterals on 13 lead ECG and thallium-201 exercise test results. Circulation 1979;59 & 60:II-266.

342. Waters DD, Chaitman BR, Theroux P, Dauwe F, Mizgala HF, Bourassa MG. Exercise testing in variant angina. Circulation 1979;59 & 60:II-265.

343. Chaitman BR, Rogers WJ, Davis K, Tyras DH, Berger RL, Bourassa MG, Fisher L, Mock MB, Judkins MP. Operative risks in left main coronary disease (CASS). Circulation 1979;59 & 60:II-59.

344. Chaitman BR, Rogers WJ, Davis K, Tyras DH, Berger RL, Bourassa MG, Fisher L, Mock MB, Judkins MP, Killip T. Sex differences in diagnostic exercise stress testing. 32eme Reunion Annuelle. Societe Canadienne de Cardilogie, Quebec Octobre 17-30, 1979.

345. Tabau JF, Dupras G, Chaitman BR, Waters DD, Bourassa MG. Breast artifacts in thallium

imaging. 32eme Reunion Annuelle. Societe Canadienne de Cardiologie, Quebec 17-20, 1979.

346. Chaitman BR. Evaluation hemodynamique des protheses porcines du type Carpentier-Edwards. Actualites Cardiologiques. Institut de Cardiologie de Montreal, Quebec Juin 7-8, 1979.

347. Taylor AW, Ferguson RJ, Petitclerc R, Ricci J, Fournier M, Montpetit RR, Chaitman BR. Cardiac and skeletal muscle adaption to continuous and short interval training in adolescent boys. Universite Libre de Bruxelles, Juin 1979.

348. Chaitman BR. New diagnostic potentials in exercise testing. Annual Meeting of the New York Cardiological Society, New York, May 12, 1979.

349. Bourassa MG, Chaitman BR. Role de la chirurgie coronairenne chez le malade peu symptomatique. Mise a Jour en Cardiolgie. Institut de Cardiologie de Montreal, Montreal, 3-5 Mai 1979.

350. Bourassa MG, Chaitman BR. Conduite a tenir devant l'atherosclerose coronarienne chez un patient peu ou pas symptomatique. Mise a Jour en Cardiolgie. Institut de Cardiologie de Montreal, Montreal, 3-5 Mai 1979.

351. Chaitman BR, Bonan R, Tubau J, Grondin CM. Clinical and hemodynamic evaluation of the Carpentier-Edwards porcine xenograft. Symposium on Bioprosthetic Heart Valves. Munich, April 5-7, 1979.

352. Bourassa MG, Chaitman BR. Le syndrome de menance au cours des atteintes du tronc commun de la coronarie gauche. Colloque international sur le Syndrome de Menance de l'Infarctus du Myocarde. Toulouse, France. 2-3 fevrier 1979.

353. Weiner DA, McCAbe C, Fisher L, Chaitman BR, Ryan TJ. Similar rates of false-positive and false-negative exercise tests in matched males and females (CASS). Circulation 1978;58:II-140.

354. Wagniart P, Chaitman BR, Krantz B, Ferguson RJ, Bourassa MG. Relation entre le produit frequence-pression a l'exercise et l'etendue des obstructions des arteres coronaires. Symposium sur les Epreuves d'Effort. Bordeaux 1977-LABAZ.

355. Chaitman BR, Wagniart P, Corbara F, Bourassa MG. Improved efficiency of the graded exercise test. Circulation 1977;56:III-13.

356. Chaitman BR, Waters DD, Corbara R, Bourassa MG. Predictors of multivessel disease following an inferior myocardial infarction. Circulaton 1977;56:III-749.

357. Mizgala HF, Chaitman BR, Theroux P, Convert G. Successful treatment of "variant angina" with oral perhexiline maleate. Circulation 1976;53:II-72.

358. Chaitman BR, Lesperance J, Bourassa MG. Changes in left ventricular function one year after aortocoronary bypass surgery. Clin Res 1976;24:#3,212A.

359. Trenouth RS, Rosch J, Chaitman BR, Antanovic R, Rahimtoola SH. Coronary angiography in the critically ill patients. Clin Res 1975;23:86A.

360. IBID. Chest 1974;66:320.

361. Chaitman BR, Bristow JD, DeMots H, Rosch J, Rahimtoola SH. Subjective vs. objective assessment of left ventricular function. Clin Res 1974;22:268A.

362. Chaitman BR, Burg BS, Kremkau EL, Rahimtoola SH. Inaccuracy of determining the magnification of X-ray images by using the cardiac catheter. Clin Res 1974;22:141A.

363. Chaitman BR, Bristow JD, Rahimtoola SW. Left ventricular wall motion assessed by using

fixed external reference systems. Clinical Research 1973;21:409.

364. Boncheck LI, Anderson RP, Rosch J, Chaitman BR, Rahimtoola SH, Starr A. Consequences of vein graft occlusion. Circulation 1973;48:IV52.

365. Chaitman BR, Bristow JD, Rahimtoola SH. Left ventricular wall motion assessed by using fixed external reference systems. Circulation 1973;48:1043.

366. Kremkau EL, Chaitman BR, Rosch J, Griswold HE. Serial left ventricular (LV) ejection fraction (EF) in patients with coronary artery disease (CAD): with and without interim myocardial infarction. Circulation 1973;48:IV-187.

367. Boncheck LI, Anderson RP, Rosch J, Chaitman BR, Rahimtoola SH, Starr A. Consequences of vein graft occlusion. Circulation 1973;48:IV-52.

368. IBID. Circulation 1973;48:IV-152.

369. Chaitman BR, Bristow JD, Rahimtoola SW. Left ventricular wall motion assesed by using fixed external reference systems. Clin Res 1973;21:409.