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## BACTERIOLOGY

<b>Demonstration of Circulating Group B Streptococcal Immune Complexes in Neonates with Meningitis</b>	Jesús G. Vallejo, Carol J. Baker, and Morven S. Edwards	2041-2045
<b>Clinical Comparison of Isolator and Thiol Broth with ESP Aerobic and Anaerobic Bottles for Recovery of Pathogens from Blood</b>	J. A. Kellogg, D. A. Bankert, J. P. Manzella, K. S. Parsey, S. L. Scott, and S. H. Cavanaugh	2050-2055
<b>Evaluation of RapiDEC Staph for Identification of <i>Staphylococcus aureus</i>, <i>Staphylococcus epidermidis</i>, and <i>Staphylococcus saprophyticus</i></b>	William M. Janda, Kathy Ristow, and Denise Novak	2056-2059
<b>Application of Typing by Pulsed-Field Gel Electrophoresis to the Study of <i>Clostridium difficile</i> in a Neonatal Intensive Care Unit</b>	Haru Kato, Naoki Kato, Kunitomo Watanabe, Kazue Ueno, Hiroshi Ushijima, Shintaro Hashira, and Toshiaki Abe	2067-2070
<b>Spread and Maintenance of a Dominant Methicillin-Resistant <i>Staphylococcus aureus</i> (MRSA) Clone during an Outbreak of MRSA Disease in a Spanish Hospital</b>	M. Angeles Dominguez, Herminia de Lencastre, Josefina Linares, and Alexander Tomasz	2081-2087
<b>Controlled Evaluation of 5 versus 10 Milliliters of Blood Cultured in Aerobic BacT/Alert Blood Culture Bottles</b>	Melvin P. Weinstein, Stanley Mirrett, Michael L. Wilson, Larry G. Reimer, and L. Barth Reller	2103-2106
<b>Concordance of Endotoxemia with Gram-Negative Bacteremia in Patients with Gram-Negative Sepsis: a Meta-Analysis</b>	James C. Hurley	2120-2127
<b>Genital Flora in Pregnancy and Its Association with Intrauterine Growth Retardation</b>	Marc Germain, Marijane A. Krohn, Sharon L. Hillier, and David A. Eschenbach	2162-2168
<b>Rapid Detection of Vancomycin-Resistant Enterococci</b>	Stephen C. Edberg, Catherine J. Hardalo, Christine Kontnick, and Sheldon Campbell	2182-2184
<b>Characterization of Strains of <i>Neisseria meningitidis</i> Recovered from Complement-Sufficient and Complement-Deficient Patients in the Western Cape Province, South Africa</b>	A. Orren, D. A. Caugant, C. A. P. Fijen, J. Dankert, E. J. van Schalkwyk, J. T. Poolman, and G. J. Coetzee	2185-2191
<b>Comparison of Sensititre Broth Microdilution and Agar Dilution Susceptibility Testing Techniques for Meropenem To Determine Accuracy, Reproducibility, and Predictive Values</b>	Michael J. Dowzicky, Harriette L. Nadler, and Waheed Sheikh	2204-2207
<b>Evaluation of Two BBL Crystal Systems for Identification of Some Clinically Important Gram-Negative Bacteria</b>	B. Holmes, M. Costas, T. Thaker, and M. Stevens	2221-2224
<b>Comparison of PCR with Culture for Detection of <i>Ureaplasma urealyticum</i> in Clinical Samples from Patients with Urogenital Infections</b>	Kui Teng, Muyiao Li, Wanfang Yu, Houjun Li, Dawei Shen, and Dexiang Liu	2232-2234
<b>Comparison of Three Commercial MIC Systems, E test, Fastidious Antimicrobial Susceptibility Panel, and FOX Fastidious Panel, for Confirmation of Penicillin and Cephalosporin Resistance in <i>Streptococcus pneumoniae</i></b>	Karen K. Krisher and Andrea Linscott	2242-2245
<b>Nosocomial Infection by <i>Staphylococcus haemolyticus</i> and Typing Methods for Epidemiological Study</b>	J. E. Degener, M. E. O. C. Heck, W. J. van Leeuwen, C. Heemskerk, A. Crielaard, P. Joosten, and P. Caesar	2260-2265

*Continued on following page*

<b>Opacification of Middlebrook Agar as an Aid in Distinguishing <i>Nocardia farcinica</i> within the <i>Nocardia asteroides</i> Complex</b>	Mara Carson and Andrew Hellyar	2270-2271
<b>Case Report and Review of Septicemia Due to <i>Serratia ficaria</i></b>	H. Darbas, H. Jean-Pierre, and J. Paillisson	2285-2288
<b>Confirmation of Human <i>Campylobacter concisus</i> Isolates Misidentified as <i>Campylobacter mucosalis</i> and Suggestions for Improved Differentiation between the Two Species</b>	Stephen L. W. On	2305-2306
<b>Demonstration of <i>Borrelia burgdorferi</i> DNA in Urine Samples from Healthy Humans Whose Sera Contain <i>B. burgdorferi</i>-Specific Antibodies</b>	Helge Karch, Hans-Iko Huppertz, Matthias Böhme, Herbert Schmidt, Dieter Wiebecke, and Andreas Schwarzkopf	2312-2314
<b>Evaluation of E Test as a Rapid Method for Determining MICs for Nutritionally Variant Streptococci</b>	Christopher P. Douglas, Steven Siarakas, and Thomas Gottlieb	2318-2320
<b>Demonstration of Persistence of <i>Salmonella typhimurium</i> in an AIDS Patient by Molecular Methods</b>	Alberto E. Fica, Harold W. Horowitz, Hermy Lior, and Felipe C. Cabello	2327-2330
<b><i>Hafnia alvei</i> in Stool Specimens from Patients with Diarrhea and Healthy Controls</b>	Jouko Ridell, Anja Siitonen, Lars Paulin, Leena Mattila, Hannu Korkeala, and M. John Albert	2335-2337

#### CHLAMYDIOLOGY AND RICKETTSIOLOGY

<b>Western Immunoblot Analysis of <i>Ehrlichia chaffeensis</i>, <i>E. canis</i>, or <i>E. ewingii</i> Infections in Dogs and Humans</b>	Yasuko Rikihisa, S. A. Ewing, and J. C. Fox	2107-2112
<b>A 1-Year Evaluation of Syva MicroTrak <i>Chlamydia</i> Enzyme Immunoassay with Selective Confirmation by Direct Fluorescent-Antibody Assay in a High-Volume Laboratory</b>	Edward L. Chan, Ken Brandt, and Greg B. Horsman	2208-2211

#### MYCOBACTERIOLOGY AND AEROBIC ACTINOMYCETES

<b>Rendering of Mycobacteria Safe for Molecular Diagnostic Studies and Development of a Lysis Method for Strand Displacement Amplification and PCR</b>	Peter Zwadyk, Jr., James A. Down, Nancy Myers, and Margaret S. Dey	2140-2146
<b>Rapid Discrimination of <i>Mycobacterium tuberculosis</i> Strains by Random Amplified Polymorphic DNA Analysis</b>	C. J. Linton, H. Jalal, J. P. Leeming, and M. R. Millar	2169-2174

#### MYCOLOGY

<b>Emergence of Fluconazole-Resistant Strains of <i>Candida albicans</i> in Patients with Recurrent Oropharyngeal Candidosis and Human Immunodeficiency Virus Infection</b>	M. Ruhnke, A. Eigler, I. Tennagen, B. Geilseler, E. Engelmann, and M. Trautmann	2092-2098
<b>Comparison of Broth Macrodilution, Broth Microdilution, and E Test Antifungal Susceptibility Tests for Fluconazole</b>	David L. Sewell, Michael A. Pfaller, and Arthur L. Barry	2099-2102
<b>Elimination of False-Positive Serum Reactivity in Latex Agglutination Test for Cryptococcal Antigen in Human Immunodeficiency Virus-Infected Population</b>	Susan Whittier, Roy L. Hopfer, and Peter Gilligan	2158-2161
<b>Strain Relatedness of <i>Candida albicans</i> Strains Isolated from Children with Leukemia and Their Bedside Parents</b>	Matsuko Doi, Michio Homma, Shin-Ichi Iwaguchi, Keizo Horibe, and Kenji Tanaka	2253-2259
<b>High Frequency of Yeast Carriage on Hands of Hospital Personnel</b>	Larry J. Strausbaugh, David L. Sewell, Thomas T. Ward, Michael A. Pfaller, Teri Heitzman, and Rita Tjoelker	2299-2300

Continued on following page

<b>First Report of Involvement of <i>Nodulisporium</i> Species in Human Disease</b>	Gary M. Cox, Wiley A. Schell, Richard L. Scher, and John R. Perfect	2301-2304
<b>Effect of Potential Interference Factors on Performance of Enzyme Immunoassay and Latex Agglutination Assay for Cryptococcal Antigen</b>	Howard D. Engler and Yvonne R. Shea	2307-2308
<b>Evaluation of New Monoclonal Antibody-Based Latex Agglutination Test for Detection of Cryptococcal Polysaccharide Antigen in Serum and Cerebrospinal Fluid</b>	Deanna L. Kiska, Deborah R. Orkiszewski, Donna Howell, and Peter H. Gilligan	2309-2311
<b>PARASITOLOGY</b>		
<b>Diagnosis of Cutaneous Leishmaniasis and Species Discrimination of Parasites by PCR and Hybridization</b>	Noris Rodríguez, Bernardo Guzman, A. Rodas, Howard Takiff, Barry R. Bloom, and Jacinto Convit	2246-2252
<b>Usefulness of PCR for Detection of <i>Pneumocystis carinii</i> DNA</b>	P. Roux, I. Lavrard, J. L. Poirot, C. Chouaid, M. Denis, J. L. Olivier, M. Nigou, and M. Miltgen	2324-2326
<b>VIROLOGY</b>		
<b>Evaluation of Two Commercial Human T-Cell Lymphotropic Virus Western Blot (Immunoblot) Kits with Problem Specimens</b>	Dana Gallo, Janice L. Diggs, and Carl V. Hanson	2046-2049
<b>Transient Antibody Responses to Hepatitis E Virus Detected by Western Immunoblot Using Open Reading Frame 2 and 3 and Glutathione S-Transferase Fusion Proteins</b>	Fan Li, Hui Zhuang, Sotirios Kolivas, Stephen A. Locarnini, and David A. Anderson	2060-2066
<b>Analysis of Sera Indeterminate by Ortho-HCV RIBA-2 by Using Three Confirmatory Assays for Anti-Hepatitis C Virus Antibody</b>	E. Dussaix, N. Charnaux, P. Laurent-Puig, S. Chopineau, Y. Laurian, and C. Buffet	2071-2075
<b>Reverse Transcription-PCR Detection of LaCrosse Virus in Mosquitoes and Comparison with Enzyme Immunoassay and Virus Isolation</b>	Leonard P. Wasieloski, Jr., Alfredo Rayms-Keller, Laura A. Curtis, Carol D. Blair, and Barry J. Beaty	2076-2080
<b>Comparison of Methods for Detection of Hepatitis B Virus DNA</b>	H. L. Zaaijer, F. ter Borg, H. T. M. Cuypers, M. C. A. H. Hermus, and P. N. Lelie	2088-2091
<b>Comparison of Four Enzyme Immunoassays for Detection of Immunoglobulin M Antibodies against Rubella Virus</b>	Lukas Matter, Meri Gorgievski-Hrisoho, and Daniel Germann	2134-2139
<b>Quantification of Human Immunodeficiency Virus Type 1-Infected Mononuclear Cells in Peripheral Blood of Seropositive Subjects by Newly Developed Flow Cytometry Analysis of the Product of an In Situ PCR Assay</b>	Maria C. Re, Giuliano Furlini, Davide Gibellini, Monica Vignoli, Eric Ramazzotti, Simona Lolli, Sergio Ranieri, and Michele La Placa	2152-2157
<b>Immunoaffinity Purification of Baculovirus-Expressed Rubella Virus E1 for Diagnostic Purposes</b>	Christer Lindqvist, Michel Schmidt, Johanna Heinola, Risto Jaatinen, Monica Österblad, Aimo Salmi, Sirkka Keränen, Karl Åkerman, and Christian Oker-Blom	2192-2196
<b>Stabilities of Quantitative Plasma Culture for Human Immunodeficiency Virus, RNA, and p24 Antigen from Samples Collected in VACUTAINER CPT and Standard VACUTAINER Tubes</b>	Larry Mole, Dan Margolis, Richard Carroll, John Todd, and Mark Holodniy	2212-2215

<b>Comparison of Peptide Enzyme-Linked Immunosorbent Assay and Radioimmunoprecipitation Assay with In Vitro-Translated Proteins for Detection of Serum Antibodies to Human Papillomavirus Type 16 E6 and E7 Proteins</b>	Yeping Sun, Keerti V. Shah, Martin Müller, Nubia Muñoz, Xavier F. Bosch, and Raphael P. Viscidi	2216-2220
<b>Early Detection of Anti-HCc Antibody in Acute Hepatitis C Virus (HCV) by Western Blot (Immunoblot) Using a Recombinant HCV Core Protein Fragment</b>	Chau-Ting Yeh, Chia-Min Han, Shih-Yen Lo, Jing-Hsiung Ou, Kong-Dee Fan, I-Shyan Sheen, Chia-Ming Chu, and Yun-Fan Liaw	2235-2241
<b>Comparison of Plasma PCR and Bronchoalveolar Lavage Fluid Culture for Detection of Cytomegalovirus Infection in Adult Bone Marrow Transplant Recipients</b>	Mary M. Aspin, Ghislaine M. Gallez-Hawkins, Terrence D. Giugni, Bernard Tegtmeier, David J. Lang, Gerhard M. Schmidt, Stephen J. Forman, and John A. Zaia	2266-2269
<b>Evaluation of Third-Generation Assays for Detection of Anti-Hepatitis C Virus (HCV) Antibodies and Comparison with Presence of HCV RNA in Blood Donors Reactive to c100-3 Antigen</b>	D. Lavanchy, C. Mayerat, B. Morel, P. Schneider, C. Zufferey, J.-J. Gonvers, A. Pécoud, and P. C. Frei	2272-2275
<b>Analysis of Hepatitis C Virus Isolates among Healthy Blood Donors and Drug Addicts in Chiang Mai, Thailand</b>	Chatchawann Apichartpiyakul, Charoon Chittivudikarn, Hirofumi Miyajima, Morio Homma, and Hak Hotta	2276-2279
<b>Distribution of Viral Genotypes in Italy Determined by Hepatitis C Virus Typing by DNA Immunoassay</b>	Antonella Ravaggi, Antonella Zonaro, Maria Grazia Marin, Massimo Puoti, Alberto Albertini, and Elisabetta Cariani	2280-2284
<b>Simultaneous Culture for Adenovirus, Cytomegalovirus, and Herpes Simplex Virus in Same Shell Vial by Using Three-Color Fluorescence</b>	Brenda G. Brumback and C. Diane Wade	2289-2290
<b>Standardized Microtiter Assay for Determination of Syncytium-Inducing Phenotypes of Clinical Human Immunodeficiency Virus Type 1 Isolates</b>	Anthony J. Japour, Susan A. Fiscus, Jean-Marie Arduino, Douglas L. Mayers, Patricia S. Reichelderfer, and Daniel R. Kuritzkes	2291-2294
<b>Detection of Human Parvovirus B19 DNA PCR Products by RNA Probe Hybridization Enzyme Immunoassay</b>	D. D. Erdman, E. L. Durigon, and B. P. Holloway	2295-2298
<b>Rotavirus Serotypes Causing Severe Acute Diarrhea in Young Children in Six Australian Cities, 1989 to 1992</b>	Paul J. Masendycz, Leanne E. Unicomb, Carl D. Kirkwood, and Ruth F. Bishop	2315-2317
<b>Genome Analysis of South American Adenovirus Strains of Serotype 7 Collected over a 7-Year Period</b>	Adriana Kajon and Göran Wadell	2321-2323
<b>Quantitative Colorimetric Microneutralization Assay for Characterization of Adenoviruses</b>	Leta K. Crawford-Miksza and David P. Schnurr	2331-2334

## CLINICAL VETERINARY MICROBIOLOGY

<b>Differentiation of <i>Salmonella</i> Serovar Infantis Isolates from Human and Animal Sources by Fingerprinting IS200 and 16S <i>rrn</i> Loci</b>	Sinikka Pelkonen, Eeva-Liisa Romppanen, Anja Siitonen, and Jukka Pelkonen	2128-2133
<b>Detection of <i>Ehrlichia risticii</i> from Feces of Infected Horses by Immunomagnetic Separation and PCR</b>	Biswajit Biswas, Ramesh Vemulapalli, and Sukanta K. Dutta	2147-2151
<b>A Simple, Specific, and Highly Sensitive Blocking Enzyme-Linked Immunosorbent Assay for Detection of Antibodies to Bovine Herpesvirus 1</b>	J. A. Kramps, J. Magdalena, J. Quak, K. Weerdmeester, M. J. Kaashoek, M. A. Maris-Veldhuis, F. A. M. Rijsewijk, G. Keil, and J. T. van Oirschot	2175-2181

- Detection of Porcine Reproductive and Respiratory Syndrome Virus and Efficient Differentiation between Canadian and European Strains by Reverse Transcription and PCR Amplification** Helmi Mardassi, Louise Wilson, Samir Mounir, and Serge Dea 2197-2203
- Development of Nested PCR Assays for Detection of Bovine Respiratory Syncytial Virus in Clinical Samples** Š. Vilček, M. Elvander, A. Ballagi-Pordány, and S. Belák 2225-2231

## EPIDEMIOLOGY

- Efficacy of Microbial Identification System for Epidemiologic Typing of Coagulase-Negative Staphylococci** David Birnbaum, Loreen Herwaldt, Donald E. Low, Michael Noble, Michael Pfaller, Robert Sherertz, and Anthony W. Chow 2113-2119

## LETTERS TO THE EDITOR

- Tox-A Test for *Clostridium difficile*** Tracy D. Wilkins and David M. Lyerly 2338
- Additional Data on Clinical Isolates of *Campylobacter mucosalis*** A. J. Lastovica, Elza Le Roux, Rob Warren, and Horst Klump 2338
- Pitfalls in Immunoblot Detection of *Aspergillus* Antigens Associated with Invasive Infection** Luc M. Wijnands, Frans M. van Leusden, Rob J. T. Puyk, Marcel P. M. Hofstee, and H. W. Boudewijn Engel 2339
- Utility of Quantitative Enzyme Immunoassay Reactivity for Predicting Human Immunodeficiency Virus Seropositivity in Low- and High-Prevalence Populations** Frank J. Michalski 2340
- E Test as Susceptibility Test for Evaluation of *Neisseria meningitidis* Isolates** Emilio Pérez-Trallero, Nieves Gomez, and José Maria García-Arenzana 2341-2342

## ERRATA

- Evaluation of Specificity of Indirect Enzyme-Linked Immunosorbent Assay for Diagnosis of Human Q Fever** Iyorlumun J. Uhaa, Daniel B. Fishbein, James G. Olson, Cornelia C. Rives, David M. Waag, and Jim C. Williams 2343
- Comparison of Four Immunoserologic Assays for Detection of Antibodies to *Borrelia burgdorferi* in Patients with Culture-Positive Erythema Migrans** Paul D. Mitchell, Kurt D. Reed, Teresa L. Aspeslet, Mary F. Vandermause, and John W. Melski 2343

## High Frequency of Yeast Carriage on Hands of Hospital Personnel

LARRY J. STRAUSBAUGH,<sup>1,2\*</sup> DAVID L. SEWELL,<sup>3,4</sup> THOMAS T. WARD,<sup>1,2</sup> MICHAEL A. PFALLER,<sup>4†</sup>  
 TERI HEITZMAN,<sup>5</sup> AND RITA TJOELKER<sup>5</sup>

*Infectious Disease Section, Medical Service,<sup>1</sup> Laboratory Service,<sup>3</sup> and Nursing Service,<sup>5</sup> Veterans Affairs Medical Center, and Division of Infectious Diseases, Department of Medicine,<sup>2</sup> and Department of Pathology,<sup>4</sup> School of Medicine, Oregon Health Sciences University, Portland, Oregon*

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**The hands of 36 nurses and 21 nonnursing hospital employees were tested by culture with a modification of the broth wash technique. Seventy-five percent of the nurses and 81% of the nonnurses were found to harbor yeasts on their hands; 58% of nurses and 38% of nonnurses were carrying *Candida* spp.**

During an investigation of funguria in our nursing home care unit (NHCU), 75% of 28 nurses were found to harbor yeasts on their hands (9). Since previous studies, which were summarized by Odds (7), reported rates of yeast carriage on hands and fingers of patients and healthy subjects ranging from 0 to 17%, we were quite surprised. Accordingly, we designed the present study to examine the frequency of yeast carriage on the hands of nurses working in three separate hospital units and to compare the frequency of yeast carriage in the nurses with that in nonnursing personnel working in nonclinical areas of our medical center.

Of the 36 nurses who participated in this study, 12 worked in the NHCU, 12 worked in either the medical or surgical intensive care unit, and 12 worked in the outpatient clinics. Of the 21 nonnursing personnel who also participated, 7 each were from our personnel, supply, and fiscal departments. A short questionnaire regarding hand washing practices was administered to all participants. Without any preparation of the hands, cultures were obtained by using the standard broth bag technique (5, 6). Both hands of all participants were placed in 20 ml of brain heart infusion broth contained in a plastic bag. Broth specimens were then transferred to sterile plastic cups. When the specimens arrived in the laboratory, gentamicin and vancomycin were added to yield a final concentration of 50 µg/ml. The cups were incubated for 6 days at 30°C, and 0.1-ml aliquots were subcultured to Bromcresol Green and Inhibitory Mold agar plates (PML Microbiologicals, Tualatin, Ore.) on days 1 and 6. Control cultures of medium-containing bags (no handwashing and no antibiotics) were performed simultaneously. No yeasts were recovered from the control cultures.

Yeasts recovered were identified with MicroScan Rapid Yeast Identification panels (Baxter Healthcare Corporation, West Sacramento, Calif.) (4). The Rapid Yeast Identification panels, containing 96 microdilution wells with 27 dehydrated substrates, were inoculated with a yeast suspension calibrated against a MicroScan turbidity standard and incubated at 37°C for 4 h in the MicroScan Walkaway system. After addition of sodium hydroxide or peptidase reagent to appropriate substrate wells, plates were analyzed for enzyme activity as

determined by color changes. Test results were digitized and compared to a computerized database to generate a list of probable species. Identifications were accepted when the percent probability exceeded 85%.

Overall, 75% of the nurses were found to harbor yeasts on their hands; 58% were intensive care unit nurses, 75% were outpatient clinic nurses, and 92% were NHCU nurses (Table 1). The hand cultures of five (83%) of six male nurses and 22 (73%) of 30 female nurses were positive for yeasts. Five of the nurses carried two species of yeasts, and 22 carried only one. Fifty-eight percent of the nurses had a *Candida* sp. on their hands; 11 had *Candida parapsilosis*, 8 had *C. albicans*, 2 had *C. lusitanae*, and 1 had *C. guilliermondi*. Other yeasts recovered from nurses included *Rhodotorula* sp. (from six persons) *Torulopsis candida* (from one), *Sporobolomyces* sp. (from one), *Trichosporon beigelii* (from one), and *Saccharomyces cerevisiae* (from one).

Eighty-one percent of the nonnursing participants harbored yeasts on their hands: 71% of the participants in the personnel department, 71% of those in the fiscal department, and 100% of those in the supply department. The hand cultures of five (100%) of five male participants and 12 (75%) of 16 female participants were positive for yeasts. Two individuals carried two yeast species, and 15 carried only one. Thirty-eight percent of the nonnursing participants harbored a *Candida* sp. on their hands; six had *C. parapsilosis*, 3 had *C. albicans*. *Rhodotorula* sp. was isolated from nine individuals, and an unidentifiable yeast was isolated from one. None of the differences between nurses and nonnurses were statistically significant, a somewhat unexpected finding in light of the differences in hand washing practices disclosed by the questionnaire.

Questionnaire results indicated that 92% of the nurses and only 28% of the nonnurses had washed their hands one or more times at work that day prior to participating in the study. Most of the nurses had washed their hands three, four, or more times, whereas none of the nonnurses had washed more than once or twice. Similarly, 50 and 78% of the nurses but none of the nonnurses had worn gloves and had direct patient contact, respectively, prior to participating in the study. About half of the nurses who had worn gloves had already used more than three pairs that day prior to participating in the study. In contrast, most of the nonnursing personnel had not worn gloves during the preceding week. On the morning of the study, hand lotion had been used by 40% of nurses and 43% of nonnurses. Lastly, about 20% of nurses, but none of the nonnurses, reported having eczema or other problems with the

\* Corresponding author. Mailing address: Medical Service (111F), Portland VA Medical Center, P.O. Box 1034, Portland, OR 97207. Phone: (503) 220-8262, ext. 7140. Fax: (503) 273-5348.

† Present address: Department of Pathology, University of Iowa College of Medicine, Iowa City, IA 52242.



TABLE 1. Hand carriage of yeasts by hospital personnel

Group and subgroup (no. of persons)	No. (%) with:	
	Any yeast	<i>Candida</i> sp.
Nurses (36)	27 (75)	21 (58)
ICU <sup>a</sup> (12)	7 (58)	4 (33)
OPC <sup>b</sup> (12)	9 (75)	8 (66)
NHCU (12)	11 (92)	9 (75)
Nonnurses (21)	17 (81)	8 (38)
Personnel (7)	5 (71)	3 (43)
Fiscal (7)	5 (71)	2 (28)
Supply (7)	7 (100)	3 (43)

<sup>a</sup> ICU, intensive care unit.

<sup>b</sup> OPC, outpatient clinic.

skin of their hands. Neither hand washing practice, glove use, hand lotion use, nor eczema had any association with yeast carriage.

The results of this study indicate that hospital personnel in a variety of clinical and nonclinical settings frequently carry pathogenic yeasts on their hands. The discrepancy between our results and data previously reported probably reflects methodological differences and not unusual characteristics of our study participants. Swab techniques, which were used in the four studies summarized by Odds (7), may be insensitive, yielding yeasts only when large numbers are present. Other investigators using the broth wash technique have reported higher yields of yeasts (1, 2, 8). For example, Horn and colleagues retrieved yeasts from 27% of nonmedical subjects, from 28% of nurses and physicians working in dermatology, and from 54% of nurses and physicians working on an oncology ward (2). *Rhodotorula* sp. and *C. parapsilosis* were the isolates most frequently recovered. The higher yields in the present study probably derived not only from use of the broth wash technique but also from addition of antibiotics to the broth, the 6-day incubation time, and use of selective media for recovery of yeasts. These methodological features were adopted from the study reported by Isenberg and associates (3), which linked an outbreak of *C. tropicalis* wound infections following cardiac surgery to a colonized scrub nurse. Transmission of yeasts by hand carriers has also figured prominently

in two reports of nosocomial *C. albicans* outbreaks and in our own NHCU funguria investigation (1, 8, 9). If transient carriage of small numbers of yeasts on the hands of health care workers can lead to cross infection and if methods like those employed in the present study are indeed more sensitive, then these methods may facilitate the detection and recognition of nosocomial yeast transmission.

In summary, these data indicate that yeast carriage on the hands of hospital personnel is more common than previously realized. They also suggest that sensitive culture techniques, such as the methods employed in this study, combined with newer, more precise genotypic fungal typing systems, may be useful in unravelling the mysteries of yeast transmission in hospitals.

#### REFERENCES

1. Burnie, J. P., F. C. Odds, W. Lee, C. Webster, and J. D. Williams. 1985. Outbreak of systemic *Candida albicans* in intensive care unit caused by cross infection. *Br. Med. J.* **290**:746-748.
2. Horn, W. A., E. L. Larson, K. J. McGinley, and J. J. Leyden. 1988. Microbial flora on the hands of health care personnel: differences in composition and antibacterial resistance. *Infect. Control Hosp. Epidemiol.* **9**:189-193.
3. Isenberg, H. D., V. Tucci, F. Cintron, C. Singer, G. S. Weinstein, and D. H. Tyras. 1989. Single-source outbreak of *Candida tropicalis* complicating coronary bypass surgery. *J. Clin. Microbiol.* **27**:2426-2428.
4. Land, G. A., I. F. Salkin, M. El-Zaatari, M. R. McGinnis, and G. Hashem. 1991. Evaluation of the Baxter-MicroScan 4-hour enzyme-based yeast identification system. *J. Clin. Microbiol.* **29**:718-722.
5. Larson, E. 1985. Handwashing and skin physiologic and bacteriologic aspects. *Infect. Control* **6**:14-23.
6. Larson, E. L., M. S. Strom, and C. A. Evans. 1980. Analysis of three variables in sampling solutions used to assay bacteria of hands: type of solution, use of antiseptic neutralizers, and solution temperature. *J. Clin. Microbiol.* **12**:355-360.
7. Odds, F. C. 1979. *Candida* and candidosis, p. 68-92. University Press, Baltimore.
8. Phelps, M., G. A. J. Ayliffe, and J. R. Babb. 1986. An outbreak of candidiasis in a special care baby unit: the use of a resistogram typing method. *J. Hosp. Infect.* **7**:13-20.
9. Ward, T. T., L. J. Strausbaugh, T. Yost, R. Tjoelker, D. Sewell, M. Pfaller, C. Joseph, and W. Wanless. 1993. Funguria in a nursing home care unit (NHCU), abstr. L-31, p. 550. Abstr. 93rd Gen. Meet. Am. Soc. Microbiol. 1993. American Society for Microbiology, Washington, D.C.