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# Georg Haas (1886–1971): The Forgotten Hemodialysis Pioneer

*“From the initial idea to the actual realization of the dialysis method, it was a very long way. I would have to say, it was the way of the Cross....”*

—Georg Haas, 1928

*The first human hemodialysis in the history of medicine was performed by Georg Haas in 1924 in the town of Giessen, Germany. The procedure lasted only 15 minutes, and hirudin served as the anticoagulant. Haas was able to develop a dialyzer consisting of U-shaped collodion tubes immersed in a dialysate bath placed in a glass cylinder. He performed several hemodialysis procedures in uremics between 1924 and 1928, and reported for the first time the clinical results obtained. In 1928, Haas introduced heparin into the dialysis procedure. Because of lack of support by the medical community, Haas was forced to discontinue his promising work. His research is a real classic in the field of blood purification.*

**T**hirty years ago, on December 6, 1971, Georg Haas died—a German internist and an undeservedly forgotten pioneer in the field of dialysis science. He was the physician who performed the first human hemodialysis in the world, in October 1924.

Prof. Georg Haas was born on April 4, 1886, in the old Bavarian town of Nürnberg, Germany, and studied medicine from 1904 to 1909 at the Universities of München and Freiburg. He wrote his doctoral thesis while attending the institute of the famous pathologist Ludwig Aschoff (1866–1942).

In 1911, Haas went to Strassburg in Alsace for further postgraduate education in the laboratories of Franz Hofmeister, one of the leading figures in the science of biochemistry and physiology at that time. There he started working on amino acid metabolism in vivo, and experimented with the removal of some intermediate products from

The term “dialysis” had been introduced into the scientific literature in 1854 by the Scottish chemist Thomas Graham (1805–1869) to describe the phenomenon of movement of various types of solutes through a semipermeable membrane due to osmotic pressure.<sup>3-5</sup>

During his experiments, Haas circulated the animal blood through the tubular membranes that comprise reed stalks, prepared according to the method described by Philippon in 1902. The “reed dialyzer” of Philippon took the form of a cylinder, 15 cm in length, with a volume of 8–10 ml and a membrane wall thickness of 0.08 mm. Philippon demonstrated the permeability of the reed membrane with regard to the numerous crystalloids, but all proteins, as well as glycogen, trypsin, and hirudin, were unable to move through it.<sup>6</sup>

Because of World War I, Georg Haas went

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death in 1971. In 1916, he attained an academic degree with his research work entitled: “Der Indikangehalt des menschlichen Blutes unter normalen und pathologischen Zuständen” (“Blood indican level in humans under normal and pathological conditions”). In this paper, among others, he pointed out the role of indican—a by-product of tryptophan metabolism—as a useful marker for the evaluation of the severity of renal impairment.<sup>2</sup> From 1921 to his retirement in 1950, Prof. Georg Haas served as medical director of “Medizinische Poliklinik” (outpatient clinic) of the Medical University in Giessen.<sup>12</sup>

**Vividiffusion**

During the war years, Haas was confronted, as he own noted, with many cases of so-called “Kriegsnephritis” (trench nephritis), a clinical condition that often progressed to fatal uremia.<sup>7,8</sup> He critically analyzed the customary therapeutic maneuvers against uremia, such as bloodletting, forced sweating procedures, and dietary protein restriction. Haas stressed that all of them were without any significant effect,<sup>8,9</sup> and that, in part, “the blood-letting is even contraindicated, because of manifested anemia and depressed erythropoiesis.”<sup>8</sup>

Logically, Haas returned to the old idea for dialysis of blood: “Considering the assumption that uremia is caused by retention of products excreted by the urine and themselves can be removed by dialysis, I reconsidered my dialysis experiments from my previous metabolic studies...”<sup>8</sup>

He noted also the advantages of the proposed dialysis method of treatment: “In this manner the red blood cells, which are very important for the respiration, and all blood proteins could be preserved, by simultaneous removal of excessive amounts of retained uremic toxins.”<sup>8</sup>

Having no access to the latest scientific publications due to communication problems during the war, Haas

Abel, Leonard Rowntree, and B. Turner from the pharmacological laboratory of the Johns Hopkins University in Baltimore, MD. In fact, the Americans were the first scientists who actually realized the principle of dialysis to remove substances from the blood of living animals: “...we have devised a method by which the blood of a living animal may be submitted to dialysis outside the body, and again returned to the natural circulation without exposure to air, infection by microorganisms, or any alteration which would necessarily be prejudicial to life”.<sup>10</sup>

**“I have tried a series of different dialyzers from a variety of materials, animal and vegetable membranes and paper dialyzers. The best implementation was obtained from collodion.”**

Abel and colleagues described their method, called “vividiffusion”: “The principle of the method consists in connecting an artery of the animal by a cannula to an apparatus made from celloidin...in the form of tubes, immersed in a saline solution or serum and providing for the return of the blood to the animal’s body by another cannula attached to a vein.... The blood leaving the artery flows through a perfectly closed system and returns to the body within a minute or two without having been exposed to contact with the air or any chance of microbial infection, while the diffusible substances which it contains can pass out, more or less rapidly through the walls of the tubes. Coagulation of the blood is prevented by injection of hirudin.”<sup>10</sup>

The newly constructed device for blood purification had been named

that “it allows the escape of the diffusible constituents of the blood, but it differs from the natural organ in that it makes no distinction between these constituents, the rate of their elimination being presumably proportional to the coefficient of diffusion.”<sup>10</sup>

Working mostly with dogs, Abel and colleagues never applied the artificial kidney on humans, despite their hope to use the vividiffusion method in cases of poisoning or other causes of acute renal impairment. The commencement of World War I limited the import of leeches as a source of hirudin from Europe, and the American investigators were forced to interrupt their intriguing research in the field of blood purification.

**The First Human Dialysis**

The credit for performing the first human dialysis belongs to Georg Haas. Returning in 1919 to civil medical work in Giessen, he became familiar with the papers of the Baltimore trio (1924), as well as with the work of the Austrian chemist Fritz Pregl (1869–1930), a Nobel Prize winner in 1923, who developed a method for preparation of collodion membranes.<sup>11</sup>

Experimenting with various types of membranes, Haas, finally, was able to conclude: “I have tried a series of different dialyzers from a variety of materials, animal and vegetable membranes and paper dialyzers. The best implementation was obtained with dialyzers manufactured from collodion with respect to fabrication, dialysis effects, safe sterilization and because they can be obtained in any geometric shape.”<sup>8</sup>

Chemically, collodion (celloidin) represents a cellulose-trinitrate, the cellulose ester of nitric acid. H. Brannconnot, a French chemist, had obtained the substance for the first time in 1833. Collodion has explosive properties due to its high content of nitrate groups, and is also known as guncotton.<sup>5</sup> It is noteworthy that soon after its discovery, guncotton was selected as

a blood transfusion pump between the artery and the dialyzer in order to overcome the resistance opposing the blood flow back to the vein. Thus, Haas used, for the first time, a prototype of the modern blood pump.<sup>1,2</sup>

*In January 1925, in a short report, Haas described some details of this first-ever dialysis of a human being in the history of medicine. As noted in the article, because the attempt was directed only to demonstrate the safety and reliability of the new technology, the procedure lasted only 15 minutes.*

In 1928, Haas reported the results of three blood cleansings (“Blutwaschungen”) in two patients with ESRD.<sup>8</sup> The first of them, a 55-kg man in very poor condition despite a protein-restricted diet, was dialyzed on January 13, 1928. The newly available anticoagulant substance heparin was used in this application for the first time.

Haas performed so-called fractionated dialysis: 400 ml of blood was withdrawn from the patient, heparinized (0.125 g of heparin in 20 ml of a saline solution), and circulated for 30 min through the dialyzer. The artificial kidney consisted of 3 glass cylinders, each with U-shaped collodion tubes with a total length of 756 cm and a surface area of 1,512 cm<sup>2</sup>. The blood was reinfused into the cubital vein. The procedure was repeated 9 times, and Haas calculated that the total removal of non-protein nitrogen was about 2,772 g. He was also able to

(indican, creatinine, phenol) in the dialysate bath.<sup>8</sup>

Haas pointed out for the first time the impressive clinical effect achieved, which lasted for 6 days after the dialysis: The patient was of high spirits, free of vomiting and headache, and the appetite improved manifestly.<sup>8</sup>

The second patient was dialyzed on March 29, 1928, and the procedure was repeated on May 4. Being an astute clinical observer, Haas noted a decrease of blood pressure and an improvement in the heart rhythm at the end of the dialysis. He was able to note a temporary reduction of diuresis, from 1,000–1,200 ml/24 h before dialysis to 507 ml on the day after the procedure,<sup>8</sup> and proposed several explanations for this event.

Haas also pointed out the decrease of blood volume during the extracorporeal circulation and noted the loss of 100 ml of water from 400–500 ml of blood during the 30-min hemodialysis session. This event was caused by ultrafiltration brought on by positive pressure in the blood compartment, not by osmotic fluid removal, because an isotonic Ringer’s solution served as the dialysate. As such, Haas recommended a hemodialysis treatment in hyperhydrated patients due to nephrotic edema.<sup>8</sup>

The author ended his article with optimism: “...despite the limited number of observations, I have already gotten the distinct impression that it is worth the effort to continue along the way taken”.<sup>8</sup>

### **A True Pioneering Effort**

Because of lack of support by the medical community, Haas was forced to discontinue his promising work in the field of dialysis.<sup>1,2,4,5</sup> Writing for the last time in 1952, Haas reminded the community that it was he, working in his laboratory in Giessen, Germany, who introduced hemodialysis as a therapeutic method.<sup>14</sup>

Fifteen years after the last human dialysis in Giessen, in the small town

Kolff (physician) and Hendrik Berk (engineer) constructed their rotating drum artificial kidney with its “large surface area.”<sup>15</sup> Their paper, published about 20 years after the first article of Haas, makes reference to him.<sup>15</sup> Thus, the way was continued....

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