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Profiles in Cardiology

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John J. Osborn

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The curious but distinct terminal aberration of the QRS complex often noted on the electrocardiogram (ECG) of hypothermic patients is now commonly known as the Osborn wave. It is fitting that Dr. Osborn's (Fig. 1) name should be held in perpetuity in association with hypothermia. His contributions to medical science were part of the pioneering effort in cardiothoracic surgery to provide surgeons with a bloodless and nonbeating heart by iatrogenically inducing hypothermia. History will reflect that he left an indelible fingerprint on the pulse of modern medical progress and technology.

While working as an Assistant Professor of Pediatrics at New York University College of Medicine in 1953, Dr. Osborn published a paper entitled *Experimental Hypothermia: Respiratory and Blood pH Changes in Relation to Cardiac Function*. In this article he describes the ECG as showing

> a secondary wave closely following the S-wave, so closely that it appears to be part of the QRS complex. Evidence from leads V_1 and V_6 indicates that this abnormal wave following S represents a current of injury, rather than a widening of the ventricular complex due to a conduction defect. This wave, which we interpret as a current of injury, is so closely associated with the QRS complex as to prevent accurate measurement of the actual duration of the QRS wave.[1]

The debate lingers as to whether this current of injury is truly part of the QRS complex and what actually causes it. What is not disputed is that the use of the term "Osborn wave" became commonplace by the 1980s, finding its way into many standard textbooks of medicine and cardiology. Exactly when the eponym stood on its own is uncertain. In 1959, D. Emslie-Smith, writing in the *British Heart Journal*, noted, "The characteristic deflection of hypothermia has sometimes been named after Osborn who discussed it in 1953."[2] In *The Lancet* in 1961, Helen Duguid remarks, "The electrocardiogram may show the distinctive 'J' or 'Osborn' waves."[3] To be sure, others had previously described similar afflictions of the QRS complex in association with low body temperature, yet it is Osborn's portrayal that seems to have captured posterity's imagination. Osborn noted some other ECG manifestations of hypothermia and, indeed, ECG changes ascribed to hypothermia can be found in the literature as far back as 1920.[4]

I recently interviewed Dr. Osborn, and he reminisced about his research. He became interested in the medical applications of hypothermia while in medical school at Johns Hopkins. Challenging the accepted notion that warm-blooded mammals could not survive deep hypothermia, he cooled anesthetized dogs to 5° C, left them without circulation for an hour and then rewarmed them. He restored heartbeat with open cardiac massage and a defibrillator consisting of two spoons with insulated handles, connected directly through a knife-switch to an electrical wall outlet. Although none of the animals survived, he was able to demonstrate brain activity after rewarming.[5] In 1943, he submitted a paper on his findings. He then graduated and embarked on a 9-month whirlwind pediatric residency and entered the U.S. Army. "I received a letter from a very nice man, Dr. Blalock (of the Blalock-Taussig Procedure) asking for revisions on my paper," Dr. Osborn recalls,"but I was lying in a tent in the rain in the Philippine Islands and revising the paper did not seem like a viable project at the time." He spent two years in the Army as a medical officer for a field artillery battalion, "waiting for the invasion of the islands that never took place because of the atomic bomb, thus probably saving my life."

Following the war, Dr. Osborn made his way to New York University College of Medicine and studied under the widely respected pediatrician Emmett Holt. However, his interest in hypothermia never cooled. Utilizing laboratory space given to him by the nephrologist Homer Smith, he resumed his research. Clinically, he was working with premature babies,

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FIG. 1 John J. Osborn, M.D. (photo taken ca. 1956).

most of whom died. "My thoughts turned toward an artificial placenta and perfusion techniques. We never were successful with the artificial placenta but realized our perfusion techniques might be useful for open-heart surgery. I fashioned my own rotating oxygenator, a wonderful 'Rube-Goldberg' apparatus," Dr. Osborn fondly recalled. In a modern day acquiescence to Horace Greeley, Dr. Osborn migrated west in 1954 to Stanford University to continue his efforts in the pioneering days of cardiothoracic surgery. There he turned his talents toward taming the temperamental heart-lung machine. His undergraduate degree in biology from Princeton did not provide him with any formal engineering training, yet this did not prevent him from contributing significantly to solving the operational problems of the heart-lung machine. In his scholarly lecture on the history of cardiac surgery, Dr. Dwight Harken refers to Era III, namely, "open heart surgery involving hypothermia, mechanical bypass or both."[6] Having already laid the groundwork with his study of hypothermia, Dr. Osborn began to perfect his heart-lung machine with the rotating disc oxygenator.[7] (Fig. 2). Teaming up with the gifted cardiac surgeon Frank Gerbode, they performed the first successful heart-lung bypass procedure west of the Mississippi in 1956 when they repaired a ventricular septal defect, thus securing an integral position in the history of cardiac surgery.

The success of the cardiothoracic surgery program at Stanford University hinged on several issues. As part of the team headed by Dr. Gerbode, Dr. Osborn was instrumental in introducing continuous hemodynamic computer monitoring of postoperative cardiac patients. They were the first to show that sudden cardiac death was not due to stray electrical currents travelling down the monitoring devices, but rather due to failure to recognize subtle changes in acid-base status, fluid balance, and other seemingly minor deviations that could lead to sudden decompensation. On his early encounters with the heart-lung machine, Dr. Osborn took great care to make two points. First was cognizance of the need to make sure that any part of the bypass machine that came in contact with the patient's blood had to be absolutely biologically and chemically clean.* As he wrote in 1960, "As a minimum, every part which can possibly touch blood should be scrubbed individually with appropriate detergent, then rinsed long and hard. All parts should be dried and coated with baked silicone before each use."[7] His second point stressed the need for a good

*The first successful use of the heart-lung machine in a human is credited to John Gibbon in Philadelphia in 1953, when he repaired an atrial septal defect. Many thought the procedure so radical that they refused to send their patients to Dr. Gibbon. With Dr. Gibbon's permission, Dr. J. W. Kirklin took the machine to the Mayo Clinic and established a successful open-heart surgical program. Dr. Kirklin had figured out what Osborn and colleagues at Stanford had learned—the heart-lung machine had to be meticulously cleaned and rinsed in order to minimize postoperative fevers, emboli, and other complications. Dr. Kirklin kept in his employ two exceptionally fastidious ladies to sanitize the machines, whose contribution to the success of the program at the Mayo Clinic may have been underappreciated.[5]

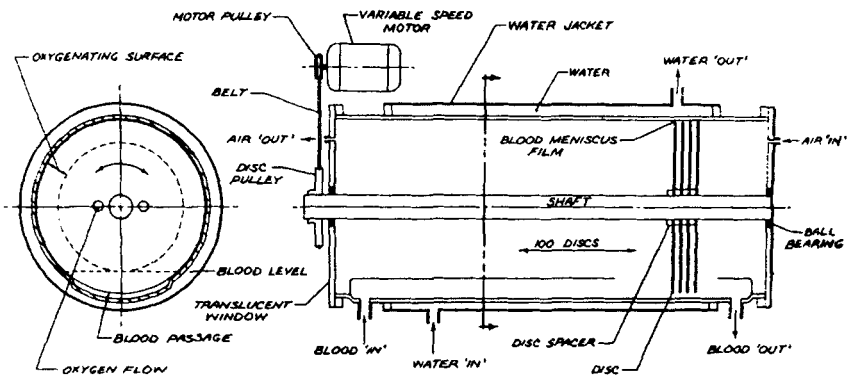

FIG. 2 Sectional diagrammatic sketch of 21 cm disc oxygenator. Reproduced from Ref. No. 7 with permission.

blood filter. Using the Swank filter developed by Dr. Roy Swank at Oregon, the team prevented the postsurgical encephalopathy related to central nervous system emboli from clumped cells. Several weeks of postoperative delirium and fevers were not unusual. Dr. Osborn's group was the first to publish the benefits of utilizing the Swank filter, describing a patient who discussed home finances with his wife the morning after open-heart surgery. Application of these principles, the meticulous attention to details, and the introduction of continuous postoperative computer monitoring culminated in an internationally famous advanced cardiac surgery unit[8] and ushered in the dawn of the intensive care unit.

The remainder of Dr. Osborn's career was spent as an intensivist at Stanford. He was a founding member of the Society for Critical Care Medicine. He published over 130 papers although he "considered only three or four of these to be of any importance." With a trace of chagrin in his voice he admitted that the article in which he described the Osborn wave had erroneous blood pH calculations because he utilized the wrong temperature corrections. His miscalculations were discovered by John Severinghaus, known for developing the Severinghaus electrode. They subsequently developed a friendship that has persevered for nearly 50 years.

Although IBM and the National Institutes of Health supplied much of the initial research funding in the incipient years of hemodynamic computer monitoring, their support eventually dwindled. Undaunted, Dr. Osborn, using venture capital, founded a business developing and manufacturing intensive care unit monitoring devices. The business flourished and in 1978, declaring intensive care medicine a "young man's game," he retired from active practice to devote his energies to the company. He eventually sold his enterprise, Research Development Corporation, to Johnson & Johnson and retired to Tiburon, California, with his wife Anne. They are the parents of seven children and grandparents of sixteen, which leaves "precious little time to pursue our love of sailing." It should be noted that the soon-to-be Mrs. Osborn, serving in the dual capacity of girlfriend and research assistant during Dr. Osborn's experiments at Johns Hopkins in the early 1940s, assiduously remarked, "If we are going to do such nasty and messy experiments, let us at least keep decent notes on what happens." And she did.[5] One of Dr. Osborn's sons, Oliver, practices medicine near San Francisco. Growing up, Oliver remembers being vaguely aware that his father was helping develop the heart-lung machine, but that his father "was very modest and never gave the impression that he was working on anything important. He seemed to enjoy what he was doing and projected that at home."[9]

Born in Detroit, Michigan, on November 5, 1917, Dr. Osborn was one of two sons and four daughters of Frederick Henry Osborn. His father was a businessman who served as a U. S. Army General of Information and Education during World War II. His career was noteworthy for helping create and introducing the G.I. Bill.

I informally polled 16 of my internal medicine colleagues, half of whom were able to tell me that an Osborn wave suggested hypothermia. Eleven of 12 cardiologists were able to answer the same query correctly. Dr. Osborn seemed truly amazed to learn that present day physicians knew anything at all about his "current of injury" as he prefers to call it. Moreover, he had no inkling that his name was being invoked in medical wards across the globe in association with the enigmatic J point deflection. "It is," he stated, simply and elegantly in his articulate fashion, "nice to be remembered."

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