2015 John H. Gibbon, Jr., Lecture

Scholarship and Insights

Mark Kurusz, CCP (Emeritus)

Austin, Texas

The Gibbon Lecture at AmSECT’s International Conference has traditionally consisted of a personal recounting about each year’s honoree—their background, who influenced them, their accomplishments, and reflections on the field of perfusion. I wish to somewhat depart from that theme and only address a little bit about how I became a perfusionist. It is really a simple story. The primary focus of this lecture is about scholarship, illustrated with some details of Dr. Gibbon’s famous case, and how remarkable insights can become apparent with the pursuit of scholarship.

Getting into perfusion was certainly not a well thought-out career plan. After graduating high school in 1964, I enrolled at the University of Miami majoring in zoology. I had vague aspirations of becoming an oceanographer. But that academic pursuit lasted only about 8 weeks, until I dropped out of college. I was restless and wanted to see some of the world and with some persistence was able to get a job out of Boston in the merchant marine. I worked steadily for nearly a year on coastwise oil tankers going back and forth between Chelsea, MA and Port Arthur, TX. While that year was not especially exciting or a way to see much of the world, it did qualify me for full membership in a maritime union. Subsequently, I sailed out of New York for 6 more years during summer and Christmas breaks after I had re-enrolled in a small liberal arts college. Then, I did see much of the world, for what it was worth.

Like many seamen, I read a lot when at sea, mostly classics in literature, and, after dropping out of college two more times, eventually graduated with a Bachelor of Arts degree in English. The same day I graduated, I got engaged to Helen, an Intensive Care Unit nurse. Later that year on a job-hunting trip, we found ourselves in a small town in Pennsylvania, location of the newly opened Hershey Medical Center. With some more vague aspirations—this time to maybe go to medical school, I got a job as an orderly, but 2 months later was offered the chance to train on-the-job as a pump tech. I took it because it paid 14 cents more per hour than what I was making as an orderly, and the idea to take some science courses to qualify for applying to medical school fell by the wayside. Dennis Williams was my mentor, and he taught as he had been taught: one-on-one in a preceptor-type situation.

As the great actor James Cagney once said of his career, “...if there’s a buck to be made, you don’t ask questions, you go ahead and make it.” Many of us in the early 1970s came into perfusion exactly that way—by being in the right place at the right time. My only previous hospital experience was as a phlebotomist and diener in a community hospital in New Jersey. The first time I carried a pager was in 1968, and as luck would have it, I got called out once to help during an autopsy late in the evening. Little did I know what it really meant to carry a pager way back then.

The early 1970s were exciting times for our field when cardiac surgery was rapidly expanding, mostly because of the coronary artery bypass operation. New extracorporeal technologies were being developed such as cardioplegia, long-term circulatory support, and extracorporeal membrane oxygenation (ECMO). We worked closely with the
surgeons at Hershey in the dog lab and helping with other research projects. It was a great time to be a perfusionist.

My first solo case was a Friday night emergency coronary artery bypass graft (CABG) surgery. Dennis Williams was out of town, and I was only a few weeks into my on-the-job training. With his frequent admonition not to pump air, I primed the bubble oxygenator with 4 L of lactated Ringer’s because I wanted to have enough volume in the circuit to avoid the risk of an air embolism. No arterial filters were used in those days and other safety devices we take for granted today were either unreliable or did not exist. At Hershey, the pump was positioned behind the surgeon. When told to start bypass, I removed the venous clamp, turned on the arterial pump, and the reservoir overflowed onto the floor. The surgeon was standing in a pool of blood and asked me if everything was OK back there. I replied, “Yes, sir, and I’m not going to pump air.” The patient survived but had a lower than expected hematocrit for several hours. Those were scary days to remember how perfusionist training was conducted back then. Clinical simulation was used, but it was not so sophisticated as simulation today: it consisted of pumping dogs and calves for research projects.

When the first pass/fail certification examination was administered by AmSECT in 1974, I took it along with 113 others and barely passed. After all, what does an English major know about pharmacology? I failed that part as well as the section on extracorporeal techniques, scoring below the 70th percentile in both, but 72.3% overall when averaging in the other 2 sections. That year, according to AmSECT, there were just 300 certified clinical perfusionists, most of who had been grandfathered into certification. Eventually, I became an author and editor. It is an avocation I have maintained to the present.

As noted, the theme of this lecture is scholarship, and I now wish to share some perspectives about the pursuit of scholarship. First, it is mostly a solitary activity as one collects and reads the literature on any given subject. It is commonly called research, but I have found that it might be better characterized as “re-re-re-research” because the pursuit typically yields other leads and more trips to the library or searching online to find additional citations. That is the fun part, but it is often accompanied by feelings of confusion until one has mastered the subject and all the resources fall into place as important publications are distinguished from mediocre ones.

The real work of scholarship begins when one develops an understanding of previous work and then puts that understanding in context with the case report, study, technique description, review—whatever one is trying to achieve—for it is only when a paper is written, to the best of your ability, and then submitted to a journal that the rewards become evident. At that stage, you are exposing yourself to one final hurdle, and that hurdle is peer review. The essence of peer review is not only to subject your paper to the judgment of others but improve the final manuscript. Very few papers are accepted outright and must be revised either in a minor or a major way before being accepted for publication. The quality of one’s scholarship often determines the degree of revision that will be needed.

The dictionary tells us that a scholar is a person who has done advanced study in a special field. What could be a more special field than perfusion? What endeavor could be more amenable to conducting advanced study than perfusion? There are so many aspects of what we do every day in the Operating Room that ought to raise questions about how and why we do what we do. Think what many of us have witnessed in our short existence: perfusion has evolved from the technician days to a bonafide profession.

I well remember the early days of the Journal of Extracorporeal Technology when I worked with Emily Taylor, Nancy Achorn, and others to produce a quarterly peer-reviewed journal. It was not easy, and any perusal of those early volumes may evoke feelings of embarrassment to consider where we were back then and where we are today. There has been a vast improvement due in no small part to the dedicated editors who followed Emily. AmSECT’s president, Jeffrey Riley, was one of those dedicated workers, and the current editor, Robert Groom, has taken the journal to new heights under his tutelage. Both are to be commended for their efforts to force us to become scholars.

So to summarize, the rewards of scholarship are really two-fold: first, individually, as one gets to know a subject well, and secondly, for the profession as the results of one’s scholarship are shared. Sharing may be by presenting a talk—at the local level or to a larger audience at a national meeting. The most lasting impact of scholarship is, however, when your work is published. Scholarship means pursuing all leads and even personal communications can be a part of that scholarship. One should always confirm primary sources and not simply repeat what others have said or written. Examples in perfusion might be the early belief that it was not possible to pump air with a centrifugal pump or bubble oxygenators were equivalent to membrane oxygenators. The pH-stat vs. alpha-stat controversy clearly evolved in our understanding on how best to manage blood gases during hypothermia and is yet one more example. One word of caution: do not rely too heavily on Perlist® postings. One can see all kinds of lazy scholarship there such as the recent blog on anticoagulation during cardiopulmonary bypass. To their credit, more than one poster, however, recommended going to the published literature to get answers rather than relying on what some have opined ad lib on a blog. I would urge you to always be skeptical of what is posted.

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Now, to give you one example of insights from scholarship, I will tell you some things you may not know about Dr. Gibbon and his team’s historic case. I dare say all perfusionists do know that an atrial septal defect was closed in a young woman for the first time using cardiopulmonary bypass in May 1953. She was very sick before the operation and had been hospitalized three times for right heart failure. A cardiac catheterization in April revealed a nine-to-one left-to-right shunt from her defect. She had limited physical activity and would become cyanotic when walking or climbing one flight of stairs. After her cardiac surgery she was discharged from the hospital cured of her heart disease and lived until age 65 years, when she died in 2000. It was a simple case, right?

That singular event marked the beginning of a new field of cardiac surgery and perfusion as we know it today. What may not be well appreciated is the fact that at least 17 other cases were performed in the early 1950s using some form of extracorporeal circulation, and only Dr. Gibbon’s patient survived (1). He had used the heart-lung machine on a child in the previous year but the case ended in failure because of a mistaken diagnosis. Cardiopulmonary bypass was by no means assured as a viable way to conduct cardiac surgery until later in the decade due primarily to successes at the University of Minnesota and the Mayo Clinic.

So what actually happened in the white-tiled operating room on the 4th floor of the East wing at Jefferson Hospital on May 6, 1953? In short, those who were there had serious challenges that fateful day 62 years ago and the patient barely survived. As we all know, there are certain dreaded events during perfusion, and the major ones are decreased blood flow, prolonged hypotension, hypoxia and acidosis, loss of circulating volume, and blood clotting in the circuit. Incredibly, all of these events occurred during Dr. Gibbon’s famous successful case.

The case was first reported in The New York Times, and a few days later in TIME magazine (2). What is noteworthy about these lay press reports is that Dr. Gibbon was reportedly shy and did not want to pose for the photographers alongside the Gibbon-IBM heart-lung machine. Instead, his laboratory technician, Miss Joanne Crothers was pictured. Dr. Gibbon, however, quoted, “The machine is not a cure-all for all heart conditions. It will probably be used chiefly on patients born with a deformed heart. It can’t help coronary artery disease....” Predictions in medicine are notoriously inaccurate, and such was the case with Dr. Gibbon’s pronouncement back then. When Dr. Gibbon did get around to writing up the case, he had to be persuaded by another early pioneer, Dr. Clarence Dennis, to present his experience that fall at a meeting in Minnesota. He reported the one successful case along with three others that were not successful in an issue of a regional journal, Minnesota Medicine, which was published in March 1954 (3). Incidentally, a brief mention of the successful case appeared in an earlier issue of Surgical Forum in 1953, when use of a vent during cardiac surgery was described (4). The 75% mortality rate—it was actually higher because Dr. Gibbon performed other cases using extracorporeal circulation, which also ended in failure but were not reported—led him to declare a moratorium on cardiac surgery at Jefferson, and he would later write that he felt as if he had opened Pandora’s Box by developing a heart-lung machine (5). In a great irony, it was only during the May 6th successful case that there were complications during perfusion, and for all other times that resulted in patient deaths the heart-lung machine functioned as designed without any problems.

So what did Dr. Gibbon report about the case? As it turns out, not very much, and some of the information was inaccurate. He wrote, “The patient was connected with the apparatus for 45 minutes...” In fact, it was for 48 minutes. During the time of support, he stated, “…all cardiorespiratory functions [were] maintained by the apparatus for 26 minutes.” Once again there is a discrepancy in what he reported and in times documented, which in reality was 27 minutes of total bypass. There were many inconsistent times recorded for how long the patient was actually on the pump.

As for the surgical procedure, he wrote in the Operative Report, “She had a large interatrial septal defect which was quite easily closed with a continuous silk suture.” Important details of the surgery and the perfusion management were not reported. During a congratulatory telephone call from Dr. Dennis, Dr. Gibbon stated, “After we finally got ready, it was ridiculously easy” (6). That assessment was not entirely true as details of the case have emerged. The Anesthesia Record from the case is remarkably neat because it was recreated after the case, as was customary back then. Vital signs were not recorded during portions of the time the patient was on cardiopulmonary bypass, and question marks were written instead because the patient’s blood pressure was unmeasurable.

The Gibbon-IBM model II heart-lung machine (7) had three roller pumps; one for drawing venous blood from the vena cavae, one for recirculation, and one for returning arterial blood to the systemic circulation. The recirculation pump was necessary to maintain a film, once established during priming, on a series of screens. There were eight screens inside a Plexiglas chamber for gas exchange. Venous blood was distributed at the top and filmed down, becoming arterial blood in the bottom of the reservoir, and an oxygen-rich atmosphere in the chamber allowed for gas exchange. The pumps were servo-regulated, and there was a flutter valve for the venous pump to prevent collapse of the vena cavae and a blood level sensor for the arterial pump to prevent the reservoir from being emptied. There also were sensors to shut down the roller pumps if the pressure exceeded 300 mmHg. Blood could only be administered into the circuit through a small burette located...
before the venous pump, and there was a reusable screen arterial filter/bubble trap.

Several pages of handwritten notes were taken during the case, and in reality, they represent the first perfusion record. Contrary to popular belief, Dr. Gibbon’s wife, Maly Gibbon, did not run the heart-lung machine that day and never did at Jefferson. Instead, she was the person who took notes for use later during a press conference if the operation was a success. Partial bypass started at 12:55 PM, and total bypass started at 1:00 PM. A careful reading of her notes reveals the following: “1:02 Art[erial] on manual” and “Large leak in top of lungs”. That was only 2 minutes after establishing total bypass. The next notation reads, “1:08 attempt to stop leak.” Despite the leak, Dr. Gibbon later reported, “It was a rather crucial point but Dr. Allbritten and I decided to go ahead with insertion of the plastic vent in the left ventricle and to proceed rapidly with the closure of the interatrial defect” (8). During the operation, Dr. Gibbon abandoned his original plan to use a pericardial patch and instead closed the defect with running suture, no doubt because of perfusion problems that had developed shortly after starting bypass.

Another notation reads, “Hi Pr[essure] in art[erial].” In fact, a surgical resident, Dr. Victor Greco, at one point climbed up on a stool to hold the Plexiglas lid in place on top of the oxygenator because he was afraid it was going to be blown off by pressure building up inside. Blood was leaking from the oxygenator, and one eyewitness said that there was blood everywhere. The next notation was, “1:15 no film on screens 1-2-3.” This was an ominous development because the oxygenator had stopped adequately transferring oxygen. The cause was blood clotting because an inadequate dose of heparin had been added to three units of fresh whole blood used to prime the machine that morning.

Dr. Gibbon, at that point, turned to Dr. Miller and exclaimed, “B.J., do something. Do something!” Dr. Miller, who without a doubt was the unsung hero that day, broke scrub and took over operation of the heart-lung machine, which had been relegated to Dr. Greco and Miss Crothers. The next 30 minutes were a perfusionist’s nightmare. A typed summary of the case was prepared afterward and became the official record of the case. There is a chronology with times, comments, flow rates, blood given, and blood pressure notations. Figure 1 is a graphic reconstruction prepared from the typed notes. There is a line representing blood flow during partial and total bypass and the Xs represent blood pressure. There are gaps between 1:20 PM and 1:40 PM when the blood pressure was unmeasurable.

The first asterisk at 1:02 PM indicates, “Large leak in top of lung. Artery on manual because of foam.” The second asterisk at 1:08 PM corresponds to, “Attempts being made to stop huge leak . . . to no avail.” This is when Dr. Greco held the lid on the oxygenator and blood was spraying everywhere and onto the floor. Other asterisks correspond to the deteriorating situation such as loss of the blood film on three of the screens. The fifth asterisk is when things went from bad to worse: “Blood loss from top of lung at rate of approximately 100 cc per minute.”

Figure 1. Graph depicting perfusion and patient parameters during operation on May 6, 1953. Times are shown on the horizontal axis beginning at 12:55 PM, blood flow rate in mL/min on the left vertical axis, and blood pressure in mmHg on the right vertical axis. The dark gray shading indicates periods of partial bypass and the light gray indicates total bypass. Recorded blood pressures are denoted by Xs or, at 1:12 PM by a V and a caret; note that no blood pressures were recorded between 1:20 PM and 1:40 PM when hypovolemia manifested. Blood volumes administered are indicated by arrows at the bottom, which totaled 2050 mL during perfusion. Asterisks indicate serious complications such as blood leaking from the oxygenator, attempts to stop the leak, loss of blood film on three screens, development of high pressure with roller pump shut-down, and administration of protamine at 1:50 PM. (See text for additional details.)
All bank blood they had on hand was given along with some saline contained in open beakers in an attempt to maintain enough circulating volume. The total volume of blood added to the circuit during the 48-minute case was 2050 mL. They came off total bypass at 1:35 PM and the patient was, “Off machine completely” at 1:43 PM, no doubt to the relief of everyone in the room. Protamine was given 7 minutes later.

There is a handwritten record of blood studies from the case. There was increasing acidosis during bypass, and one column reported arterial and venous oxygen saturations. The arterial saturation on the first blood gas at 1:15 PM was 56.7% and, 15 minutes later it had dropped to 31.8%. “The blood was black,” according to one eyewitness.

Because of blood clotting in the oxygenator and loss of circulating volume, the low-level sensor shut down all the roller pumps. At this point, Dr. Miller quickly bypassed the recirculation pump, a move that allowed some blood to refill the reservoir, and began manual operation of the venous and arterial pumps to maintain perfusion. Venous blood bypassed the oxygenator, and the last several minutes of perfusion were for circulatory support alone, albeit with desaturated blood. With volume replacement, manually assisted circulation, and release of the caval tapes, the patient’s blood pressure returned to 50–60 mmHg systolic from being unmeasurable during the crisis.

Because of the urgency of the situation, and at Dr. Allbritten’s urging, Dr. Gibbon closed the atriotomy with a Satinsky clamp so the patient could be rapidly weaned from the heart-lung machine. The patient was severely acidic and the heart fibrillated. Two counter-shocks were required to reestablish normal sinus rhythm. Because of these near-catastrophic events, there was some concern for the patient’s neurological status, and all anesthetic drugs were stopped for more than an hour until the end of the operation. In fact, the patient woke up on the table when skin sutures were being placed. By 9:00 PM on the evening of surgery, the patient had been extubated, and was “completely lucid,” according to a resident’s note.

Twenty-five years later, the patient was featured in an article published in the Philadelphia Evening Bulletin (9). She was quoted as saying, “On that morning I knew things could only go one way...Call it a youthful hunch, a teenager’s female intuition or whatever—I felt it would go my way with Dr. Gibbon’s machine and lots of prayers.” A truer statement about this case was never uttered. It is interesting to also note she was offered the option of hypothermia with inflow occlusion for closure of her septal defect, but said she couldn’t stand the idea of being frozen, so opted for the heart-lung machine.

So, that is the story of Dr. Gibbon’s famous case, and the insights just recounted were from scholarship I conducted from a variety of sources including reviewing all of Drs. Gibbon’s and Miller’s publications on the case, reading the book, John Gibbon and His Heart-Lung Machine (10) by Ada Romaine-Davis, reviewing medical records and the Gibbon files at Scott Memorial Library at Thomas Jefferson University and the National Library of Medicine, interviewing, visiting, and corresponding with Dr. Miller, and speaking with other personnel who were either in the Operating Room that fateful day or were close associates of Dr. Gibbon.

In summing up, I wish to express my thanks to several individuals I have come to know well over the years: Chan, Hill, Riley, Groom, Taylor, de Jong, and Toomasian—these are friends I first met in a professional capacity—first, as a member of the AmSECT ethics committee and later participating in international standards work with Richard Chan; American Board work, research collaborations, and AmSECT standards development with Aaron Hill; publications, panels, and scholarly justing with Jeff Riley; conducting survey research and editorial collaborations with Bob Groom; participating in the Hammersmith Perfusion workshops and editorial work with Professor Ken Taylor; attending international meetings with Dick de Jong; and learning about ECMO and undertaking many editorial duties with John Toomasian. All of these individuals have been engaged for decades in the profession by organizing and speaking at scientific sessions for the various organizations. All have demonstrated scholarly pursuits for which we are indebted. Despite occasional differences as we continue to work together, I value these long-lasting friendships.

I must also acknowledge a special appreciation to our dearly departed Maddie Massengale-Beall (11) and the early editor of the Journal of ExtraCorporal Technology, Emily Taylor. Both recruited me to volunteer time to AmSECT in the mid-1970s. They were special ladies who moved us ahead during our profession’s formative years. But, as I have tried to convey—you, I, all of us are not finished yet. Scholarship is a vital way to continue the work, and I would urge each of you to add to the body of perfusion literature in addition to your important clinical duties. Throughout most of his career, Dr. Gibbon would operate clinically in the mornings and then go to the laboratory or pursue scholarly activities in the afternoons, and that seems like a good model any perfusionist can follow. If you would desire to become a scholar, even once, I would urge you to not always be a “pump-and-go-homer.” Research a topic and write a paper. You will be amazed and rewarded, I can assure you.

In closing, I wish to express profound thanks to my wife, Helen, who has tolerated far more than could ever be expected of a spouse in time away from family, my three daughters, and in particular, Becky, whose circumstances of birth drove me most of my career. She was with us for 30 years, which was about 15 more than predicted, largely
due to the unremitting care and advocacy for her welfare by my wife. Becky had 35 operations in her life and succumbed after the last one ten years ago. She was and is my inspiration.


REFERENCES