More Than Turning Knobs: The Expanding Role of the Clinical Perfusionist

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Abstract

The practice of clinical cardiovascular perfusion has experienced major changes in scope since its inception over thirty years ago. The tasks of today's clinical perfusionist may include not only the usual life support of patients undergoing cardiac surgery, but also such diverse duties as IABP therapy, VAD life support, artificial heart management, blood salvage for autotransfusion, rapid fluid administration, ECMO therapy, liver transplantation, circulatory support for cardiac arrest, and perfusion for distant heart-lung procurement for transplantation.

All of these duties are practiced by the perfusion team of the Johns Hopkins Medical Institutions. Except for the normal surgical tasks of a perfusionist, these tasks have been assumed by the perfusion team over a recent three year period with no increase in staff. Certain managerial and team strategies were necessary to achieve this without sacrificing either patient safety or staff morale.

Introduction

On October 3, 1930, Dr. John Gibbon was a surgical resident with a problem. He spent the night caring for a young woman who was dying of a pulmonary embolus. Earlier discussion with a senior surgeon had revealed to Gibbon that removal of the thrombus from the woman's pulmonary tract was not technically difficult. In fact, the senior surgeon had removed many pulmonary emboli—from cadavers. Pulmonary embolectomy on a living patient would remain impossible, he averred, because a patient could not survive the necessary interruption of his circulation and respiration.

Despite Dr. Gibbon's best efforts, the young woman with the pulmonary embolus died about dawn of October 4. This young woman's untimely death was the seminal event which planted a thought in the mind of Dr. Gibbon—why not a machine? Why is there no machine to temporarily support a patient's circulation and respiration? In 1934, without encouragement from the medical community, Dr. Gibbon began experiments aimed at developing what would ultimately be known as the heart-lung machine. On May 6, 1953, John Gibbon's work moved from the theoretical to the pragmatic. During 26 minutes of extra-corporeal circulation, John Gibbon was able to successfully close the large ASD of a young female patient.[1] Gibbon's work not only allowed successful intracardiac surgery—he had also created the first clinical perfusionist.

The early days of cardiac surgery were not easy ones for the first perfusionists. In his 1955 publication of *Surgery of the Heart*, Dr. Charles Bailey declared that ". . . it is fair to say that the heart-lung apparatus has caused the death of more patients than it has helped. . ." and dismissed extra-corporeal circulation as an interesting technology not yet ready for clinical use.[2] He then proceeded to describe cardiac surgery using more prudent modalities such as immersion hypothermia, blind dissection, and parent-child cross circulation. Despite Dr. Bailey's opinions—or perhaps because of them—most cardiac surgery programs soon adopted extra-corporeal circulation as the state of the art in cardiac surgical life support.

The first perfusionists were MDs, mostly surgical residents and research physicians. In fact, a stint on the "pump team" was a required part of many cardiothoracic surgical residency programs. These earliest perfusionists were an innovative lot, often shuttling the same equipment between the laboratory and the OR. Equipment was often devised on a per required need basis, and new devices for better extra-corporeal perfusion proliferated at an incredible rate. Ultimately, as cardiac surgery changed from the stuff of fantasy to a more common surgical miracle, the first non-MD perfusionists began plying the perfusion trade. These perfusionists had no common educational background, and came mostly from the ranks of nurses

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and respiratory therapists. All were "on the job" trained, often in the fashion known as "see one, do one, teach one."

By the early 1960s the responsibility for cardiopulmonary bypass rested with OJT perfusionists. Surgeons were now free to consider more esoteric uses for cardiopulmonary bypass. Such modalities as extracorporeal membrane oxygenation life support, ventricular assist, and cardiac rescue all had their beginnings in this period. This period was a time of tremendous growth, which saw the development of such now common modalities as disposable perfusion circuitry, arterial filtration, and pump alarm systems. Perhaps most significant for perfusionists were the openings of the first organized perfusion training programs.

The 1970s showed a rapid growth in the number of cardiac surgical programs and a similarly rapid growth in the number of perfusionists. Most were OJT trained, but in 1972 the American Society of Extra-Corporeal Technology (AmSECT) established the first certification examination for perfusionists[3]. Perfusion was moving from the realm of skilled trade to profession as more perfusion schools opened and an accreditation program for them was established by the newly established American Board of Cardiovascular Perfusion.

By the 1980s perfusionists were spending increasing amounts of their clinical time outside the cloistered realm of the cardiac operating rooms. Intra-aortic balloons, ventricular assist devices, liver transplantation, and heart prostheses all began to fall into the perfusionist's clinical sphere. As the perfusionist's role was expanding, though, the doorway into the perfusion occupation was narrowing. On April 15, 1981, in a move which is still being debated, the American Board of Cardiovascular Perfusion, the sanctioning agency of perfusion certification, effectively closed the board examination to OJT perfusionists. For better or worse, perfusion was now a restricted medical profession.

The examination of the perfusion team at The Johns Hopkins Medical Institutions begins in the late 1950s. At this time Johns Hopkins trained its first perfusionists. Their training period was a month. They had no written curriculum or course of study. In spite of these shortcomings this sort of perfusion training persisted at Johns Hopkins until well into the 1970s. The length of training changed, however, eventually extending to about a year. The perfusion administrator of the hospital preferred to train his own perfusionists. His stated purpose was that on the job training ensured consistency and conformity of technique on "his" perfusion team. At that time the duties of the perfusion team were limited strictly to cardiopulmonary bypass in the OR with two perfusionsists working each and every case.

By 1983, the pressures of an increasing caseload forced an end to the practice of training perfusionists on the job at Johns Hopkins. It was no longer feasible to spend a year or more training "pump techs." The hospital began to hire its first school trained perfusionists. This immediately caused a rift within the perfusion team. The school trained perfusionists frequently balked at accepting the narrow definition of their jobs and the views of the perfusion administrator in clinical matters. At the same time, the surgical staff was expressing interest in expanding the perfusionist's role to include some of the newer life support modalities.

In 1985 the original perfusion administrator left Johns Hopkins and the perfusion team was free to pursue a more enlightened, less restricted mode of operation. The first expansion of the perfusionist's role at Johns Hopkins was in the area of ventricular assist.

Our ventricular assist experience began as an 11th hour situation. A heart transplant recipient was found to be incapable of separation from cardiopulmonary bypass after a lengthy transplant procedure and the decision was made to employ right ventricular assist. A few factors limited this decision. There was no ventricular assist protocol, no centrifugal pump and no one had any experience in this matter. A centrifugal pump was borrowed from another hospital and the procedure began. Despite problems of scheduling and staffing, as well as lack of experience, the RVAD procedure took place for four days until the patient expired of overwhelming sepsis.

Although our initial VAD experience was unsuccessful, much was learned from it. It became obvious early that it was no longer possible to have two perfusionists on every case, as well as a perfusionist caring for a patient in the ICU. To do so would have resulted in surgical cases begin delayed or cancelled, a situation which our surgeons found unacceptable. Instead, each case was assigned a primary perfusionist and an assistant perfusionist. The assistant perfusionist's tasks included performing blood gases and heparin titrations for two cases, while the primary perfusionist on each case ran the heart-lung machine. The assistant would also assist the primary perfusionist on other appropriate duties. These roles would rotate throughout the perfusion team equally, as would the duty of managing the ventricular assist procedure in the ICU. This practice minimized the number of hours each perfusionist had to work, as well as improving team morale during a difficult period.

The next expansion of the perfusionist's role at Johns Hopkins was in the area of blood conservation. At the

request of the surgeons and in response to a growing public desire for bloodless surgery, the perfusion team obtained a pair of Haemonetics Cell-Saver 4 devices.[a] These devices soon became extremely popular in the operating rooms, even in services other than cardiac. At about the same time, perfusion team members suggested the use of ultrafiltration hemoconcentrators as needed in cardiac surgery. Another blood conservation methodology employed by the perfusion team was the use of a cardiotomy chest drainage system for the reinfusion of shed mediastinal blood. We borrowed this method from the Cleveland Clinic and it was eagerly adopted by the surgical and nursing staffs at Hopkins. These combined modalities allowed surgery on patients with much lower red cell volumes with no increase in the number of units of blood products used.

Liver transplantation at Johns Hopkins began in 1986. The perfusionist's services were required again. The need for rapid fluid administration was met with a homegrown system utilizing a pair of cardiotomy reservoirs, appropriate tubing, a cardioplegia heat exchanger, and a roller pump. Preservation of circulatory integrity during the anhepatic phase of the operation was accomplished utilizing a centrifugal pump. Additionally, the perfusionists were required to run the Cell-Saver during these procedures, though attempts to teach other OR staff to run these units met with some limited success.

The technologies mastered during the liver transplant experience enabled the perfusionists to assist in the repair of dissecting aneurysms of the aorta. By utilizing rapid fluid administration and the Cell-Saver, our surgeons have been able to effect repairs of certain aortic aneurysms without the need for systemic heparinization and cardiopulmonary bypass. This technique has also proven valuable in trauma cases.

In 1986, our cardiac transplant surgeons expressed the desire to harvest heart-lung blocs up to 1000 miles from our hospital. Prior to this, it had been our technique to transport heart-lung donors to our hospital for organ harvest utilizing core-cooling with cardiopulmonary bypass. The logistics of this procedure were difficult and the request to transport the donor often met with resistance by the donor's family. A portable heart-lung machine was designed and tested by the perfusion team at Johns Hopkins and made successful distant heart-lung procurement possible. A perfusionist now travels with the transplant team on all heart-lung procurement trips.

In 1986 our cardiac surgical service acquired a Novacor LVAS[b]. This device, while not an artificial heart in the strictest sense, is a prosthetic left ventricle designed for implantation in those patients suffering acute left ventricular failure for whom a bridge to transplant is necessary. In a single clinical experience to date, the members of the perfusion team monitored and operated the Novacor LVAS system for 74 days. Additional work with the Novacor LVAS is planned for the future and the perfusion team will be responsible for its management.

Emergency circulatory support has recently fallen under the purview of the perfusion team. A recently acquired Bard CPS system[c] is now being used by the perfusion team as an alternative to conventional CPR in cardiac arrest situations and has been used to good effect on several occasions.

The next expansion of the perfusion team's role will be the area of extra-corporeal membrane oxygenation. Currently an ambitious research program of ECMO work is ongoing and we expect to be in clinical application by July of 1988. Again, this task will require the expertise of the perfusionists.

All of the listed tasks have been assumed by the perfusion team over the last three years, and yet there has been no increase in staffing. Perfusion team members generally do not complain of overwork, staff turnover is low, and perfusion team members seem pleased to have the multitude of tasks that are expected of them.

One reason for this is the increasing use of technology to minimize some tasks. An example of this is our use of the CDI in-line blood gas monitor[d] on all cases. This device has minimized the need to perform blood gases during the case and made one-person perfusion effective and safe. Perfusionists who would otherwise have to sit in the OR and monitor a case that they are not running are thus freed for other tasks.

Staff input represents another source of perfusionist satisfaction. Perfusionists are now routinely solicited by our surgeons for their opinions regarding new equipment and new programs, and this information weighs heavily in decision-making.

Dissemination of information is another managerial technique which has worked well for the Johns Hopkins perfusion team. The perfusion supervisor has instituted weekly meetings during which the perfusion team is informed as to the status of various projects and events concerning them. Perfusion team members are encouraged to contribute information and opinions at these meetings.

In conclusion, the Johns Hopkins perfusion experience demonstrates that perfusion need not remain

a Haemonetics Corp., Braintree, MA 02184
b Novacor Medical Corp., Oakland, CA 94621
c C. R. Bard, Inc., Billerica, MA 01821
d Cardiovascular Devices, Inc., Irvine, CA 92714

in the OR. Perfusionists can be a vital part of the health care system and they can expect to find themselves more satisfied as a result. It will be necessary to think and do things a little differently if we are to rise to meet the new challenges.

References

1. Bone, DK, Williams, WH, Hatcher, CR: Techniques of cardiopulmonary bypass and its complications, *The Heart*, Hurst, J.W.(ed) New York, McGraw-Hill Book Co., 1982, p. 1895.
2. Bailey, CP, *Surgery of the Heart*, Philadelphia, Lea & Febiger, p. 55.
3. *Booklet of Information*, September 1986, American Board of Cardiovascular Perfusion, Hattiesburg, MS, p. 3.