

Classic Pages of the *Journal of ExtraCorporeal Technology*

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Roush RE, Beall AC, Nathanson JM, Beall MM. Trends in the training of cardiopulmonary perfusionists. *J Extra Corpor Technol.* 1984;16:116–20.

It seems fitting to change gears to the topic of education in the classic section of JECT—especially because one of the authors of this 1984 classic paper, Madeline Massengale Beall, rightly earned AmSECT’s honored 2005 Gibbon Award. One of the many amazing things about Madeline is the fact that she was present for and influential in every major professional milestone in perfusion, either educational or political.

The topic of professional education should be on every perfusionist and surgeons’ minds these days. Roush’s article places the genesis of US perfusion education in historical perspective whether you believe in on-the-job, hospital-based, baccalaureate, or masters-prepared perfusionists. Remember when the minimal level of education for a perfusionist was a controversy (1–3)? In 2005, a quiet debate surrounds the methods of earning your masters in perfusion (the terminal degree in our profession) and is there still use for a bachelor’s degree in perfusion (4–6)?

Roush et al. explain that before the 1970s, surgeons were “intimately involved” in the evolution of perfusion equipment and techniques. As we know, the role of perfusionist was passed from MDs and PhDs to RNs and pump techs in the late 1960s. With the passing of the daily pump-work baton came the responsibility to build educational programs both for basic education and continued professional education. Some of the milestones described in the article that Madeline aided AmSECT to develop and spin-off were a certifying body for practicing perfusionists and a review committee for perfusion education programs.

The authors quoted a 1983 Mark Richmond report that a perfusionist performed an average of approximately 147 cases per year in 1981 in the 680 hospitals known to perform open-heart surgery (2). The average annual caseload

today is substantially less and takes place in many more hospitals. In 1983 there were eleven accredited perfusion education programs—there are 21 today—down from a much higher level in 1996 (4–6).

Roush, Nathanson, and the Bealls described an educational program that embraced the concept of cross-training perfusionists with physician assistants so that perfusionists could fulfill additional roles in the hospital. It is interesting that the four-perfusion programs that historically embraced cross-training with physician assistants are no longer active. There are two programs today that “cross-train” with biomedical engineers (<http://www.msoe.edu/grad/msp/>) and pharmacologists (<http://www.perfusion.arizona.edu/>).

The article summarized by stating: “These remarkable advances in cardiac surgery were accompanied by and, in part, made possible by the contributions of cardiopulmonary perfusionists who assisted surgeons in bringing extra-corporeal circulatory equipment and procedures to the present state of custom and use.” There are still numerous opportunities for accomplishment.

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Trends in the Training of Cardiopulmonary Perfusionists

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Abstract

While the most significant developments in perfusion technology have occurred in the past twenty-five to thirty years, interest in extracorporeal circulation was evident as early as the 18th Century. In this article (1) early developments in the field up to the first use of a heart-lung machine by Gibbon are traced; (2) development of accreditation and certification processes is described; (3) data on the current and continued need for perfusionists in the U.S. are presented; and (4) the Baylor College of Medicine baccalaureate program in perfusion is described. One conclusion drawn from information on the need for perfusionists and from information concerning extent of perfusion education is that perfusionists could work more effectively with surgeons than is presently the case if they are more broadly trained and, consequently, delegated greater responsibilities in and out of the operating room.

Introduction

It is perhaps an understatement to point to the mutually dependent relationship between the development of the perfusion profession and the progress made in open heart surgery during the past three decades. Thus, using quotes regarding achievements in the field of intracardiac surgery by an individual who contributed to the perfection of

current surgical and perfusion techniques couches this article in a retrospective frame of reference. According to Michael E. DeBakey, "The development of the heart-lung machine, another product of research, opened a new field of surgery that permits the correction of cardiovascular disease in victims previously doomed to death," ... and "bypass operations for coronary artery and other arterial occlusive diseases, including stroke, have become common."¹

In the remainder of this article, information is presented on some of the most important developments in open heart surgery, the training of cardiopulmonary perfusionists, and the recently developed baccalaureate degree program in perfusion at Baylor College of Medicine.

Historical Overview

Although significant developments in perfusion technology have occurred rapidly over the past twenty-five to thirty years, interest in perfusion began as early as the 18th Century with scientists eager to find "the anatomical seat of the soul" or "the essence of life."²

In 1813, J. J. C. LeGallios became interested in reviving animals after experiments that involved ablation (or removal) of the animal's body parts or functions.² In his book, *Experiments on the Principle of Life*, LeGallios reported the following:

"But if the place of the heart could be supplied by injecting and if with a regular continuance of this injection there could be furnished a quantity of arterial blood, whether naturally or artificially formed, supposing such a function possible, then life might be indefinitely maintained in any portion."³

Curtis described how, within the same decade, James Philip Kay carried out LeGallio's suggestion:

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Kay's success led to the increased study of circulation with artificial perfusion.²

Loebell, Brown-Sequard, and Bidder observed the electrical contractility of muscles and the output of isolated kidneys with syringe perfusion beginning just after the mid 1800's. Following this, in 1868, Ludwig and Schmidt developed the gravity reservoir. In 1885, Von Frey and Grubner developed the first "respiration apparatus," and Jacobi in 1890, developed an apparatus that oxygenated blood by allowing gas to flow through it. This apparatus, however, was plagued, as were others, with problems of hemolysis. In 1910, Hoffman and Hooker designed a pulsatile rather than a steady flow pump. Then Dale and Schwartz developed a considerably more successful "atraumatic pump" in 1927 which removed the piston from mechanical contact with the blood stream. Until now experiments were done on isolated organs and interest was beginning to focus on using extracorporeal circulation in the whole organism.²

During the early 1900's many of the exceptional, and often baffling, problems associated with circulating blood were resolved via discoveries such as heparin that ultimately permitted the development of the heart-lung bypass machine. In 1931, John Gibbon and his wife, Mary, began, and subsequently devoted many years of research, to perfect an artificial, outside-the-body, heart-lung machine that would take over the body's vital pumping and oxygenating functions.⁴ By 1935 the apparatus was good enough to take over the functions of the heart and lungs of a cat for almost four hours.⁵ Additionally, improved methods to pump blood such as the DeBakey Roller Pump became available.⁶ By 1951 development of the pump-oxygenator had been such that Clarence Dennis attempted the first clinical application in a human, but, unfortunately, the results were not successful.⁷ After further research on the apparatus, Gibbon first successfully used the bypass machine on a human patient in May 1953. Following two more operations, both unsuccessful, Gibbon became discouraged and did not use his machine again. Consequently, issues over the practicability of the heart-lung machine were raised in the surgical world.⁸

Other surgical techniques for open heart surgery were being perfected in the early fifties. With excellent results, John Lewis regularly closed atrial septal defects under direct vision utilizing inflow occlusion with moderate total body hypothermia.⁹ Hypothermia and inflow occlusion allowed surgeons

to perform cardiac surgery on a dry heart under direct vision. Many surgeons, especially Henry Swan, popularized the repair of simple, congenital cardiac defects using hypothermia.¹⁰

With the discovery that a very small cardiac output was sufficient to sustain the vital organs safely in animals for at least 30 minutes at normothermia, open heart surgery took on a new dimension.¹¹ Lillehei termed the findings regarding low flow, the "Azygos Flow Concept," and this led to the first controlled "Cross Circulation" operation that used an anesthetized donor who was connected by groin cannulations and served as the extracorporeal oxygenator. A simple mechanical finger-type (Sigmamotor) pump substituted for the heart. Forty-five cross circulation operations were performed during March 1954 to July 1955.¹²

Lillehei continued his efforts to simplify Gibbon's original heart-lung by-pass machine. In 1955, working with Richard DeWall, Lillehei began routine clinical use of a very simple bubble oxygenator.¹³ Although strongly criticized by many, the bubble oxygenator became a success because of its many practical advantages. Lillehei described the bubble oxygenator as being heat sterilizable, easy to assemble and check, consisting of no moving parts, and as being disposable.⁸ Subsequently, many improved oxygenators (bubble, screen disc, and membrane) were developed and introduced into clinical use. Description of these, however, is beyond the scope of this presentation.

With exceptional contributions by researchers and physicians such as Dennis, DeWall, Gibbon, Lewis, Lillehei, Swan, and DeBakey and his colleagues, tremendous advances in open heart surgery have been made in the last 25 years.*

Development of Accreditation and Certification

In the early years of open heart surgery, surgeons were intimately involved in the design of equipment and the conduct of extracorporeal perfusion. As surgeons became more concerned with the techni-

*Readers desiring a more in-depth treatment of developments in the field of extracorporeal circulation technology than the overview provided herein are referred to a work by George Clowes.¹⁴

ques of the surgical procedure itself, the perfusionist came into being from a wide variety of allied health professions. Most training programs were of the on-the-job type and no mechanism of certification was available.

Subsequently, the American Society of Extracorporeal Technology (AmSECT) developed a certification and recertification program and established minimum standards for cardiovascular perfusion training programs. In 1975, the American Board of Cardiovascular Perfusion (ABCP) was formed and certification and recertification responsibilities were transferred from AmSECT to ABCP. Additionally, ABCP accepted the AmSECT minimum standards for training programs and began the accreditation process. Approximately 12 programs were eventually accredited by this mechanism,¹⁵ and ABCP set the date of April 15, 1981 as the application date beyond which they would not accept for certification examination candidates not graduating from an accredited training program.

Following the recognition of cardiovascular perfusion technology as an emerging allied health profession by the American Medical Association (AMA), the Committee on Allied Health Education and Accreditation (CAHEA) formed a Joint Review Committee for Perfusion Education (JRC-PE). This Committee was composed of representatives of AmSECT, ABCP, the Society of Thoracic Surgeons (STS), the American Association for Thoracic Surgery (AATS), and the AMA. The JRC-PE established essentials and guidelines for accredited training programs. Subsequently, as of July 1984, 11 training programs have been accredited by CAHEA, and most of the other ABCP accredited programs (now 11 in number) are in the process of transition to CAHEA accreditation. The ABCP serves as the agency to certify graduates from the 22 accredited programs who successfully sit for the national certifying examination administered by that organization. Additionally, the ABCP offers a recertification program, constantly updates the validity and reliability of the testing instrument, and conducts workshops for the training of oral examiners.

Current and Continued Need _____

Due to improved surgical procedures and remarkable advances in perfusion technology equipment

and techniques, perfusion technology programs are rapidly becoming more extensive, detailed and, hence, more challenging than previous on-the-job training programs. In a "Statement on Extracorporeal Technology," the AATS and the STS encouraged and supported the efforts of extracorporeal technologists to insure continued competence in their area of medical care by providing educational programs such as those of AmSECT.¹⁶

Mark G. Richmond, Executive Director of the American Board of Cardiovascular Perfusion, presented some very useful statistics regarding perfusion manpower.¹⁷ In Richmond's poll of the 680 hospitals known to perform open heart surgery, data were collected from 385 hospitals which showed that the total number of cases from the responding hospitals during the 1979-1981 period increased from 103,277 to 141,533. With an average of 354 cases per hospital (1981 figures), there were 95.7 cases per surgeon and 146.7 cases per perfusionist. Interestingly, there was an average of 2.7 perfusionists per hospital and 3.8 surgeons per hospital. In the aforementioned hospital poll, respondents were asked if they anticipated a change in the number of cases or in the demand for perfusionists or if there was a current need for perfusionists in the hospital. On the whole, it was found that the responding hospitals expected an increase in the demand for perfusionists to continue. Data were collected also on the functioning of the perfusionist. The hospitals were polled as to what percentage of time was spent by the perfusionist on perfusion-related activities versus non-perfusion-related activities. Of the 385 hospitals responding to the survey, 210 of the hospitals expected their perfusionists, or allowed their perfusionists, to serve in functions unrelated to perfusion. The other 175 hospitals reported that perfusionists in their hospitals worked only on perfusion-related duties.¹⁷

According to his data, Richmond concluded that with regard to current demand for perfusionists, there exists a balance with the supply.¹⁷ The 12th edition of the *Allied Health Education Directory*, however, noted that the demand for perfusionists exceeded the supply.¹⁸ Furthermore, in two recent issues of *Perfusion Life*, a publication of AmSECT, 16 openings for perfusionists were advertised.¹⁹ It would appear, therefore, that presently some question exists regarding whether or not manpower needs of this field are being met.

The Perfusion Technology Program at Baylor College of Medicine

Included in the 11 CAHEA accredited programs is the Perfusion Technology Program at Baylor College of Medicine in Houston, Texas, which is one of only three programs in the United States presently granting the baccalaureate degree. Baylor's Perfusion Technology Program is an example of an expanded, clinically oriented program leading to the award of a Bachelor of Science degree. Two years of acceptable, transferable college credit are required to enter the program. The program is 24 months in length and is divided into 12 months of basic science instruction and 12 months of clinical training conducted at the Veterans Administration Hospital, Ben Taub General Hospital, The Methodist Hospital and other clinical facilities within and outside of The Texas Medical Center. The perfusion technology students take the one-year basic science curriculum of Baylor's Physician Assistant Program before beginning the clinical phase of their program. The rationale for including the perfusion technology students in the Physician Assistant Program is twofold:

1. the practicality of including the baccalaureate-level perfusion technology students with other baccalaureate-level allied health students, and
2. to broaden the training base for perfusionists who graduate from the Baylor program.

Following the one-year basic science curriculum, perfusion students take several weeks of clinical experience in medicine, pediatrics, surgery, and obstetrics and gynecology. This general medical clinical training is taken prior to the required coursework and clinical experience in the traditional extracorporeal technology curriculum.

James P. Dearing, B.S., C.C.P., Director of the Extracorporeal Circulation Technology Department at the Medical University of South Carolina, was a cofounder of the first baccalaureate-level perfusion technology program in the United States at Ohio State University. According to Dearing, there is a need for diversity in academic options for extracorporeal circulation technologists in order for the profession to evolve in a viable manner.²⁰ The program at Ohio State initially emphasized engineering aspects of perfusion in both the cardiopulmonary and renal areas. Recently, the Ohio State program has de-emphasized the renal perfusion area. Some recent Ohio State graduates have obtained employ-

ment in the cardiac rehabilitation field based on their monitoring training and experience.

The Baylor Perfusion Technology Program offers a combined tract program whereby a student may be credentialed as both a perfusionist and a physician assistant, thus offering a wider range of employment opportunities or roles. Based on Richmond's 1983 survey, which revealed that many hospitals require their perfusionists to assume additional duties, it would appear that a broader scope of clinical training could benefit perfusionists in that they could function better in these other areas. Just as physician assistants now serve as extenders of primary care physicians, more broadly trained perfusionists would not be limited strictly to the operation and monitoring of extracorporeal circulatory equipment in the operating room. If cardiopulmonary perfusionists functioned as extenders of the surgeon, they could be delegated greater responsibility both in and out of the operating room.

The Perfusion Technology Program At Baylor College of Medicine exceeds the minimum standards required by the JRC-PE, is producing disciplined and competent perfusionists who have basic science and clinical orientation, and is constantly striving to provide its students with the latest perfusion knowledge and skills. Due to the broad training perfusionists obtain in the Baylor College of Medicine Program, this baccalaureate model may prove to be efficacious to surgeons in the most advanced hospitals where intracardiac surgery is performed and also to the developing countries where some nonsurgical personnel are in short supply or inadequately trained.

Having begun with quotes by Michael E. DeBakey, it seems fitting to end this perfusion-related article with a quote from another expert and pioneer in the field, C. Walton Lillehei, who said, "The past 30 years has seen spectacular progress in the development and application of methods for the diagnosis and correction of virtually all types of congenital and acquired cardiac conditions. The keystone to this astonishing progress has been the development and refinement of methods for safely breaching the anatomic barrier to the interior of the living human heart. These methods for open heart surgery have allowed surgeons to empty the heart of blood, stop its beat, if necessary; open any desired chamber; and safely carry out reparative procedures in a relatively unhurried manner."¹⁸

These remarkable developments in open heart

surgery were accompanied by and, in part, made possible by the contributions of the cardiopulmonary perfusionists who assisted surgeons in bringing extra-corporeal circulatory equipment and procedures to the present state of custom and use.

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