

The Surgical Intensive Care Unit of The Mount Sinai Hospital:

A Brief History Focusing on Contributions to Academic Critical Care Medicine and Excellence in Patient Care

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Abstract

The Mount Sinai Hospital Surgical Intensive Care Unit (SICU) was founded in 1969. Drs. William Shoemaker and Christopher Bryan-Brown were the first directors. Since it was founded, the SICU has been an integral part of the Mount Sinai Medical Center, providing a wide variety of clinical services including critical care, central line placement, and nutritional consultation. As one of the largest training programs in the United States and a frequent contributor to the medical literature, the SICU has also played a vital role in academic critical care medicine.

Key Words: Critical care medicine, intensive care unit, history.

MODERN CRITICAL CARE MEDICINE was born in the late 1960s. The original multidisciplinary medical and surgical intensive care units (ICUs) were based on medical care provided in cardiac and cardiac surgical intensive care units, as well as in recovery rooms. In April 1970, The Mount Sinai Hospital renovated the Falk building, originally completed in 1931, and established its first Surgical Intensive Care Unit (SICU), hence the name "Falk ICU." The Society of Critical Care Medicine, the world's leading critical care organization, was founded that same year. The Falk building admirably housed the initial 21-bed unit with two additional research beds for nearly 20 years.

Dr. Christopher W. Bryan-Brown, The Mount Sinai Hospital's first intensivist and current vice-chairman of Anesthesiology at Montefiore Hospital Medical Center, recalled that (1), "much of the early opposition to recovery rooms and ICU's in the United States came from hospital administrators. They did not wish to find the funds to train and maintain skilled staff, whose services previously have been provided haphazardly but at others' ex-

pense. In 1969, I witnessed Leslie Rendell-Baker, the Chairman of Anesthesiology, and Alan Kark, the Chairman of Surgery, at the Mount Sinai Medical Center in New York take on a very reluctant hospital administration for a full-time salaried physician to work in a newly proposed ICU. The administrative powers contended that the ICU could be run by an anesthesiologist who would perform his duties there when not occupied in the operating room. Confronted with data from other prestigious institutions nationwide, the administration was convinced, and I began my career as a full time salaried ICU director of a multispecialty unit."

Dr. William Shoemaker joined Dr. Bryan-Brown soon thereafter. Dr. Shoemaker was the first editor of the journal *Critical Care Medicine*, the author and editor of the first textbook dedicated to critical care medicine as a separate discipline, and a researcher par excellence. He authored several hundred peer-reviewed publications over the course of his career, the focus of his research being the physiologic response to injury and the potential to manipulate physiologic responses in order to improve outcome. Almost single-handedly, he built upon the basic physiologic principles of oxygen delivery and consumption, and developed the ideas of pathologic supply dependency as an entity and supra-normal oxygen delivery as a treatment mode. These latter two concepts have been at the heart of a long controversy within the critical care

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community, with ardent supporters and equally impassioned detractors. Interestingly, the current SICU staff is entirely in the camp of the impassioned detractors.

Dr. Koing-Bo Kwun, who is currently professor and chairman of surgery in Yeungnam University Hospital in Korea, followed Drs. Shoemaker and Bryan-Brown as director. I trained under the next Director, Dr. Thomas Iberti, who had an untimely death at age 40 in 1993. The current director, Dr. Ernest Benjamin, first came to Mount Sinai as an anesthesiology resident via Haiti and France at about the same time that Dr. Iberti became the director. Thus, in the 30 years since the SICU was founded, there have been only five directors. I think this has accounted for its consistency in personality and approach, stressing collegiality, excellence in patient care regardless of the time of day or night, education of medical students, residents and fellows, and research.

Under Dr. Iberti's leadership, the first critical care fellows were trained. They were Drs. David Gentili (an internist), George Gabrielson (an anesthesiologist), and Kathleen Kelly (a surgeon). Dr. Gentili eventually returned to his home country of Venezuela and became director of an intensive care unit; Dr. Gabrielson remained at The Mount Sinai Hospital and is an associate clinical professor of anesthesiology and director of liver transplantation anesthesia; and Dr. Kelly went on to become the director of the SICU in Morristown Memorial Hospital in New Jersey. Since that time, the Mount Sinai Critical Care Fellowship Program has grown under the direction of Dr. Oropello and myself. It has been approved by the American Boards of Internal Medicine and Anesthesiology. To date, more than 100 fellows have graduated and our program is one of the largest in the country. We also participate in the training of the pulmonary critical care fellows who are in the Pulmonary Critical Care Division of the Department of Internal Medicine directed by Dr. Alvin Teirstein.

Over this past 30 years, the Surgical Intensive Care Unit has been moved several times to accommodate its growth. It is now in the new Guggenheim Pavilion which was designed by the world renowned architect I.M. Pei. The staff has grown from the original two attending physicians to five, along with two research nurses, a database coordinator, a computer network administrator, a biochemist, and two secretaries. Our fellows rotate through the City Hospital Center at Elmhurst, the Bronx Veterans Administration Medical Center, and Engle-

wood Hospital in New Jersey. One of our graduates is in charge of the SICU at each of these hospitals. At The Mount Sinai Hospital, we cover the SICU, the neurosurgical intensive care unit, which is now a stand-alone facility, the surgical nutrition support service and the central venous access service. Thus, our clinical services touch upon the lives of literally thousands of patients yearly.

The following short review will trace some of the contributions made to critical care by the Mount Sinai team during the past 15 years.

Pulmonary artery catheterization was a technique developed for clinical use during the 1960s that became commercially available in 1970. Originally, pulmonary artery catheters were developed to assist in the management of patients experiencing myocardial infarction complicated by hypotension and congestive heart failure. However, medical and especially surgical ICUs embraced this invasive technologic advance with such exuberance that one author of a very popular handbook (2) concluded that "the pulmonary artery catheter is not just important for the specialty of critical care, it is responsible for the specialty of critical care." Early users of this device were discouraged because of the time required to place it and the often life-threatening arrhythmias experienced. However, in 1985, Iberti and Benjamin published a study demonstrating the safety and speed with which these catheters could be inserted, thus assuring their general acceptance by the critical care community (3).

Since then, complications of central venous access in general, and pulmonary artery catheterization in particular, became a favorite subject of reporting by the SICU staff. Physical complications that were reported for the first time, or in case series, included delayed (4) and bilateral chylothorax (5), delayed bilateral pneumothorax (after a single puncture) (6), malposition outside of the central circulation (7), and position in a left-sided superior vena cava (8). Later, Dr. Oropello and the SICU group postulated a possible unrecognized complication of vessel dilation, and recently have been in consultation with industry to reduce this risk (9). These publications have been widely referenced and some are included on the package inserts of the commercially available central venous access kits. Furthermore, Dr. Kwun was among the first, if not the first, to report percutaneous cannulation of the brachial vein using Seldinger's technique (10). This is now the predominant percutaneous method of insert-

ing central venous catheters from an extremity vein.

More important, in 1984, Dr. Iberti, recognizing the high incidence of avoidable complications from central venous catheterization and opposing the “see one, do one” approach to teaching invasive procedures, established the first and only ICU-based vascular access service. Now known as the Central Venous Access Service, it places approximately 1,200 central venous catheters per year in non-ICU patients, with a major complication rate, including pneumothorax, of less than 0.5%. This service, located within the SICU, operates out of a procedure room equipped with its own fluoroscopy unit and ultrasound vessel finder probe. It is staffed by a dedicated full-time nurse. To my knowledge, no other center has this service, or any reasonable facsimile. In its 16 years of existence, it has prevented innumerable morbidities and mortalities.

Pulmonary artery catheters were used to obtain physiologic information that was previously unavailable and impossible to ascertain by other means. By 1988, however, there was a growing suspicion in the critical care community that the overall outcome of patients did not seem to be significantly improved with these data. Dr. Iberti suspected that part of the problem was that physicians and nurses did not understand how to use the device. He recruited me to assist him in developing a short exam of multiple-choice questions to test this hypothesis. We formed the Pulmonary Artery Catheter Study Group, which included several leading physicians from the United States and Canada. In what has subsequently been acknowledged as a landmark study, the exam was administered to 496 physicians in 13 hospitals in these countries, to assess their knowledge and understanding (11). The mean test score was 67% correct. Astoundingly, there was a general misunderstanding and lack of knowledge about some of the most basic information required to use this device safely and effectively. For example, from a hard copy pulmonary artery wedge pressure tracing, only 47% of the respondents could correctly identify the wedge pressure. This was big news, big enough to warrant a story in *The Wall Street Journal*. Subsequently this same questionnaire was administered to critical care nurses (12, 13), and European physicians (14), and as a take-home exam to Society of Critical Care Medicine members (15). Each time this exam was administered, Dr. Iberti’s original hypothesis was confirmed — that the personnel in

charge of inserting and maintaining pulmonary artery catheters, and interpreting the information derived, lacked the basic knowledge and skill to do so. This led to standardized education programs for physicians and nurses which mandate that any outcome studies examining pulmonary artery catheterization ensure that the physicians and nurses can correctly use and interpret information gained from this device.

This academic achievement led to my involvement in the Society of Critical Care Medicine Consensus Committee (16) for which I wrote the “chapter” on perioperative pulmonary artery catheterization with Dr. Beilin, another anesthesiology staff member with whom I have frequently collaborated (17).

The SICU’s latest publication concerning pulmonary artery catheterization examined whether standard central venous and atrial pulse tracings recorded by bedside monitors would detect a, c and v waves. It was concluded that, for the most part, these waveforms were not routinely detected by the common strip-chart recorders (18). Hence, many of the long-held beliefs regarding the observation and interpretation of these waveforms are probably based upon theory and laboratory monitoring, not bedside clinical practice.

As a result of our dissatisfaction with pulmonary artery catheterization, we explored other monitoring devices. Gastric tonometry looked hopeful to many in the critical care community in the early 1990s, but our research and that of others has significantly dampened enthusiasm. A case report of a patient with gastric ischemia pointed out the limitations of this device (19) and a subsequent book chapter written by members of the SICU staff reviewed its limitations and concluded that it was not a useful clinical adjunct (20). Although tonometry is commercially available and much easier to use now, only a handful of centers are using this device.

Just before he died, Dr. Iberti began collaborating with Dr. Martin Goldman, the director of noninvasive cardiology, whose facilities are in close proximity to the ICU. Dr. Goldman has long been recognized as an expert echocardiographer and a leader in transesophageal echocardiography. Transesophageal echocardiography is the echocardiographic method of choice for critically ill patients because of the ease with which a tracheally intubated patient may be examined and the superior quality of images obtained compared to transthoracic echocardiography. The utility of transesophageal echocardiography (TEE) performed on SICU patients

by intensivists who were not expert echocardiographers was explored. After Dr. Iberti's death, Dr. Benjamin and his staff pursued this line of investigation. This research culminated in a publication that demonstrated the utility of TEE and, more important, its potential superiority to pulmonary artery catheterization (21). We coined the term "limited scope TEE" to refer to examinations done primarily to evaluate global left ventricular function and filling that could be performed by intensivists after a relatively short period of training. This area of monitoring is being explored by a growing number of intensivists worldwide. More recently we participated in a multicenter study investigating the utility of a new miniature probe the size of a standard naso-gastric tube that may change the face of ICU monitoring in years to come (22). This probe can be inserted easily and left in place for prolonged periods, yielding excellent continuous echocardiographic images.

The Surgical Intensive Care Unit staff was also among the first to report on a wide variety of clinically useful approaches and techniques that had been unrecognized or had only been practiced sporadically prior to publication. These publications in peer-reviewed journals included the utility of bedside percutaneous gastrostomy tubes (23), use of bedside diagnostic laparoscopy (24), continuous infusion of verapamil for control of supraventricular arrhythmias (in the pre-diltiazem era) (25), the common occurrence of benign thrombocytopenia after abdominal surgery (26), and the prevalence of depression among ICU patients (27).

We were the first to report a new, easy, inexpensive, and effective way to monitor intra-abdominal pressure using an indwelling Foley bladder catheter (28, 29). This method can be used when increased intra-abdominal pressure is suspected and for the diagnosis of an intra-abdominal compartment syndrome.

In 1990, we reported that hyperlactatemia could be present even in the face of a normal anion gap (30). Until this publication, traditional medical teaching was that, without an elevated anion gap, hyperlactatemia was unlikely to be present and testing for it was not cost effective. However, this teaching did not take into account the multitude of simultaneous acid-base abnormalities that critically ill patients have and the intravenous infusion of fluids which may be lower or higher than the patient's arterial pH. This publication was also among the growing body of intensive care literature demonstrating the futility of trying to

apply general medical principles derived from the outpatient setting and from patients suffering from single-organ dysfunction, to patients with multi-organ dysfunction on life support in the intensive care unit.

We were the first to show that the administration of alprostadil does not prevent renal dysfunction in liver transplant recipients (31). This was our first randomized double-blind study performed entirely within the confines of our own intensive care unit. Prior to this report, alprostadil was widely used and variously reported to decrease intraoperative bleeding, reduce postoperative renal dysfunction, reduce mortality and decrease the length of stay (32). Our clinical impression that this drug was highly overrated was widely challenged, but a follow-up study confirmed this conclusion. The now infrequent use of this drug in liver transplantation has resulted in significant cost-savings (33).

We also have developed an animal laboratory and biochemical research facility currently under the direction of Dr. Manasia. Some of the lines of investigation have included the monitoring of shock (34–37), utility of novel therapies (38–40), measurement of extravascular lung water using bioimpedance (41) and the measurement of molecular compounds to indicate the extent of reperfusion injury (42). The multidisciplinary nature of these studies requires the participation of colleagues from medicine, plastic surgery and transplant surgery.

Critical care medicine in the 1990s will probably best be remembered for the hype and hope that monoclonal antibodies would be the magic bullet to markedly reduce mortality from sepsis and septic shock. We, along with virtually every other major academic unit in the country, participated in these multicenter investigations with great hope, oftentimes as one of the leading recruiters of patients (43–45). Unfortunately, to date, all of these investigations have yielded disappointing results and the "magic bullet," if there is one, remains elusive. Most recently, we participated in the investigation of insulin-like growth factor for the treatment of acute renal failure (46). I believe that the amount of research on "growth factors" will grow exponentially in the coming decade.

However, something has changed in our unit and probably in critical care medicine in general. Compared to 20 years ago, despite the lack of any single demonstrable advance, the outcome from the Adult Respiratory Distress

Syndrome has improved dramatically, and other critical care entities have seen a subtler decline in mortality. For instance, in 1998–1999, of 42 patients who required hemodialysis and mechanical ventilation, 27 (64.3%) survived to hospital discharge. Perhaps more impressively, of 49 patients who spent more than 30 days in the ICU, 27 survived to hospital discharge (47%). Although I don't have comparative data from our SICU 10 years ago because an electronic database wasn't in place then, these survival rates greatly surprise most non-ICU physicians. I attribute these remarkable recovery rates to a large variety of factors including: (a) the persistent, aggressive, uniform nature of care our team delivers day in and day out; (b) the stress we put on each individual patient's outcome and not on our unit's length of stay or overall performance compared to some arbitrary benchmark; (c) the pioneering and judicious use of continuous veno-venous hemofiltration; (d) the onsite presence of an ICU fellow and the continuous availability of an ICU attending regardless of the time of day or night; (e) the excellent nursing and support staff and, lastly, (f) the presence of state-of-the-art technology for which we have various hospital administrators and department chairmen to thank. This last factor is probably the most tenuous of all, given the ubiquitous "cut costs now" approach that has permeated our entire health care system.

Looking forward, as the Surgical Intensive Care Unit enters the new millennium, I hope that its achievements over the next 30 years approach those of our past 30 years. That alone would be a truly remarkable accomplishment.

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