The evolution of cardiothoracic critical care

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Cardiothoracic (CT) critical care is being recognized as an emerging specialty within the frameworks of CT surgery and general critical care. The overall field of CT critical care is broadening to include not only the care of patients undergoing classic cardiac surgical operations but also the care of patients undergoing minimally invasive surgery and endovascular interventional procedures.

Studies documenting important incidences of major complications and mortality after classic cardiac surgical operations, such as coronary artery bypass grafting,^{1,2} emphasize the importance of critical care for patients undergoing CT surgery. CT critical care has 2 goals: to facilitate a rapid recovery and to prevent or effectively treat complications. The keys are being proactive rather than reactive, anticipating major changes and complications, and intervening early to minimize the effects of such changes and complications on outcome. The mainstays are monitoring, detection, and early response.

THE EMERGING SPECIALTY OF CT CRITICAL CARE

It is fortunate that therapeutic technology has advanced in several directions. We now have a number of less invasive treatment options, including peripheral perfusion systems, off-bypass surgery, percutaneous interventions, and video-assisted/robotic surgery. Our supportive care armamentarium has expanded as well and includes advanced ventilator systems, extracorporeal membrane oxygenation, ventricular assist devices, continuous renal replacement therapy, and a large pharmacopeia of new drugs, including extended applications of standard drugs and new drug combinations that did not exist 20 years ago.

Although the CT surgeon has traditionally provided perioperative care with the assistance of residents and fellows, the introduction of the 80-hour work week for residents has meant that the house staff is not routinely available to manage patients in the intensive care unit (ICU). Specialists from a variety of disciplines are filling the gap, and CT critical care teams are changing to a multidisciplinary team.

This team now includes CT surgeons, intensivists, anesthesiologists, hospitalists, critical care nurses, nurse practitioners, physician assistants, perfusionists, respiratory therapists, pharmacists, and nutritionists. It is essential that these multidisciplinary professionals communicate well and share a broad understanding of the patient's needs and situation, so that they can function well as a team, enhance the speed of the patient's recovery, and improve the quality of the patient's care, safety, and comfort.

The increasing complexity of CT critical care requires a new level of critical care performance. Some of the specialty's major challenges are (1) a rapid evolution in critical care concepts, pharmacology, and technology; (2) the unique physiologic states and complications experienced by CT patients; (3) the aging CT patient population that has more advanced primary disease and associated conditions; (4) major advances in surgical techniques, interventional procedures, and the accompanying technology; (5) national regulations limiting house staff work hours that have increased the shortage of critical care staff; (6) the difficulty of providing comfortable care when patients are subjected to multiple negative sensory inputs, including monitoring sounds, alarms, and technical language and procedures; (7) the increasing number of disciplines necessary to provide optimal CT critical care; and (8) the widely documented compromises in medical practice safety.³

I believe the answer to these challenges is a systems-structured, issue-oriented, multidisciplinary approach to CT critical care.

PERSPECTIVE

My perspective has been shaped by experiences as a resident in general surgery, a fellow and resident in CT surgery, 20 years as a full-time cardiovascular surgeon, and, most recently, experience as a CT surgeon focused on CT critical care.

As a first-year resident in general surgery at Massachusetts General Hospital, I was confronted with the difficulty of applying the "problem-oriented" approach to medicine,⁴ developed by a former medical school professor of mine, Lawrence L. Weed, to critical care situations. As I used this approach to cope with the rapidly changing scenarios of surgical patients in the ICU, it became clear to me that it did not function well in this setting. I became convinced that a "system-structured" approach would provide the framework to effectively manage patients with rapidly changing conditions.⁵ As I defined this approach, I became aware that John W. Kirklin,⁶ a mentor for many of the

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cardiac surgeons of his time and my future mentor, had described a systems approach in one of his lectures.

As I experienced the complexities of providing critical care to CT surgical patients, I found that a combination of both the problem-oriented and system-structured approaches provided the most efficient and physiologically logical way to treat CT critical care patients. In practice, then, once the patient's system-structured profile has been defined, management is guided by defining issues such as low cardiac output, renal failure, or sepsis, all of which may affect multiple organ systems.

THE SYSTEM-STRUCTURED, ISSUE-ORIENTED APPROACH

A systems analysis is the first step in creating a management plan for CT patients who require critical care. The unique cardiovascular support technology of cardiopulmonary bypass exemplifies the need for a systems-structured approach. Cardiopulmonary bypass affects virtually all body systems. Vasomotor tone is altered, fluid shifts occur, pulmonary function is compromised, and acute kidney injury may occur.^{7,8} In addition, the gastrointestinal tract is affected and complications, such as ileus and pancreatitis, are not uncommon. Neurologic dysfunction occurs often and important hematologic issues, such as coagulopathies, can develop. Glycemic control is compromised, and microbiologic events, such as nosocomial infections, are seen regularly.

Using information technology to define the function of the body systems is very helpful. As a full-time CT surgeon at Georgetown University Hospital in Washington, DC, and as director of the Heart Transplant Program there, I found myself reviewing a large amount of data every day. I relied on the hospital information system and homemade patient cards to organize and analyze these data. After I moved to George Washington University Hospital in 2001 and became director of the CT ICU, I found that our information technology was still not sufficiently advanced to display a system-structured profile for each patient. To facilitate a system-structured, issue-oriented approach, I designed a flow card to provide a framework for our management discussions at the bedside (Figure 1, A and B). On rounds after the system-structured profile was defined, the issues were identified and recorded on the flow card. Diagnostic and treatment plans were then worked out for each issue. With the advanced technology now available, systems-structured data and treatment plans can be organized, displayed, and then recorded in an electronic medical record.

DEVELOPMENT OF CT CRITICAL CARE AS A SUBSPECIALTY OF THORACIC SURGERY

In the 1970s and 1980s, before the legislation that created the 80-hour work week for residents, the postoperative care of patients undergoing major CT procedures was the

responsibility of the CT surgical house staff under the direct supervision of the operating surgeon. Although patients in the ICU might have had their care partially supervised by intensivists, pulmonologists, or cardiologists, it was clear to the house staff that the surgeon who had performed the operation was directly responsible for the patient's well-being. Residents were trained to understand that intensive or critical care was a core component of thoracic surgery.

Since the 80-hour work week was instituted, nonthoracic surgical physicians and allied professionals have, by necessity, taken over the bedside direction of critical care at a variety of medical centers. An important question is, who supervises these new members of the team? At some centers, senior nonsurgical intensivists now have the supervisory role that operating surgeons had in the past.

Although this new system of critical care supervision has been adopted by a number of major medical centers, most CT surgeons trained before introduction of the 80-hour work week believe that the operating surgeon should continue to have a major role in postoperative care. In 2007, I⁹ voiced this position in an editorial. Most thoracic surgeons agree that no one understands a patient's operation, the anticipated postoperative course, and the potential complications as profoundly as the surgeon who performed the operation. If the CT surgeon is not available, this role can be assumed by a fellow CT surgeon who has known the patient and who has performed the same or similar procedures in the past. Of importance is the fact that the patient and his or her family have placed the patient's life in the hands of the operating surgeon.

It is fitting that CT surgeons have had a fundamental role in the development of the new specialty of CT critical care. In 2004, I recruited an outstanding faculty of CT surgeons, as well as intensivists and multidisciplinary allied professionals, to launch the first international continuing medical education conference dedicated to the emerging new specialty. The conference was titled "Cardiothoracic Surgical Critical Care: A Cross-Disciplinary Specialty of Evolving Concepts and Therapeutics." Among the 11 CT surgeons on the faculty were guest speakers Joseph Dearani, Douglas Mathisen, and William DeVries. Since that time, the conference has become an annual event and prominent CT surgeons continue to participate as faculty. To recognize the merging of specialties in CT surgery, the name of the conference was changed in 2008 to "Cardiovascular-Thoracic Critical Care." The keynote speaker at the 2008 conference, Dr Bruce Lytle, spoke about the merging of the specialties of CT surgery, interventional cardiology, and interventional radiology.

The annual conference has been embraced by a number of organizations, including the American College of Chest Physicians and the Society of Critical Care Medicine. In 2005, a nonprofit educational organization called the

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		MD's		
Allergies:		Family	Occup	
Problems/Issues		Meds	Studies	
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2				
3				
4				
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6				
7				
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10				

Critical Care Flowcard

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A

Date	CV	CV	CV	Resp	Resp	CXR	Renal	GI	GI	N	Hem	Hem	Met	Inf	Ab's	Issues → Plans
POD	P's	Rhy		Ven		PEI	I&O	PE/Lab	Nu/Rx		Coag	Antico	DM	Lab	Events	
	S	R	CI	FI	Ex		B	AbD - +	NPO	A	Hct	ASA			WBC	
	M	SR	AF	O.S	Re		C	BS + -	PO	FC	PI	Clo			TM	
	P	Jn	PM	RR	RDI		UF I C	BM + -	TF	M4E	PT	HIV				
	C	PVC's	VT	AC	ABG		HD I C	NGT	TPN	S	INR	HSC	Alb	TP	C's	
				CPAP				Bi ½	PPN	C	PTT	War	ISC			
				TV				AP	H ₂ RA	L		IVCF	OH	IIV		
				PEEP				ALT	PPI	U		ICD's				
						PEI / 6	Wt	AST	MotE	P						
	S	R	CI	FI	Ex		B	AbD - +	NPO	A	Hct	ASA			WBC	
	M	SR	AF	O.S	Re		C	BS + -	PO	FC	PI	Clo			TM	
	P	Jn	PM	RR	RDI		UF I C	BM + -	TF	M4E	PT	HIV				
	C	PVC's	VT	AC	ABG		HD I C	NGT	TPN	S	INR	HSC	Alb	TP	C's	
				CPAP				Bi ½	PPN	C	PTT	War	ISC			
				TV				AP	H ₂ RA	L		IVCF	OH	IIV		
				PEEP				ALT	PPI	U		ICD's				
						PEI / 6	Wt	AST	MotE	P						
	S	R	CI	FI	Ex		B	AbD - +	NPO	A	Hct	ASA			WBC	
	M	SR	AF	O.S	Re		C	BS + -	PO	FC	PI	Clo			TM	
	P	Jn	PM	RR	RDI		UF I C	BM + -	TF	M4E	PT	HIV				
	C	PVC's	VT	AC	ABG		HD I C	NGT	TPN	S	INR	HSC	Alb	TP	C's	
				CPAP				Bi ½	PPN	C	PTT	War	ISC			
				TV				AP	H ₂ RA	L		IVCF	OH	IIV		
				PEEP				ALT	PPI	U		ICD's				
						PEI / 6	Wt	AST	MotE	P						

Name

Wt.

Critical Care Flowcard

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B

FIGURE 1. Flow card designed for “system-structured, issue-oriented” critical care management. A, Front side of flow card. B, Back side of flow card.

Foundation for the Advancement of Cardiothoracic Surgical Care was created. From the beginning, the board of directors of this foundation has included CT surgeons and allied multidisciplinary professionals. Major thoracic surgery organizations have supported the development of the specialty. In 2007, the Society of Thoracic Surgery passed legislation to endorse the annual conference, and in 2010, The American Association for Thoracic Surgery formally

became a co-sponsor of the 2010 conference and is providing accreditation. Recent studies have documented improved outcomes and decreased mortality in centers where dedicated cardiac surgical ICUs have been created and quality improvement programs established.^{10,11} Such clinical experiences emphasize how CT critical care has evolved into a unique specialty.

THORACIC SURGERY LEADERSHIP IN DEVELOPING CERTIFICATION IN CT CRITICAL CARE

The number of thoracic surgeons interested in obtaining certification in CT critical care from the American Board of Thoracic Surgeons (ABTS) has been increasing steadily. In June 2008, the ABTS expanded a meeting in Chicago to include a discussion on how to establish ABTS critical care certification. It is noteworthy that the definition of thoracic surgery published by the ABTS states that the following: "Thoracic surgery encompasses the operative, perioperative, and surgical **critical care** of patients with acquired and congenital pathologic conditions within the chest."

At this meeting, I joined ABTS Chair Richard H. Feins, Thoracic Surgery Directors Association President John H. Calhoun, and other members of the Board in discussing a CT critical care curriculum and certification issues. The discussion included defining requirements for certifying new residents, graduates of fellowships, and CT surgeons who want to concentrate their practice in critical care. The group decided that certification would be based on a combination of criteria, including clinical experience, fellowships, training courses, continuing education activities, and a certification examination. Discussions are ongoing at this time.

SUMMARY

Critical care has long been recognized as a core component of thoracic surgery and has evolved into a multidisciplinary specialty. Optimal CT critical care should employ a system-structured, issue-oriented approach using advanced information technology, and the team should ideally

be led by the CT surgeon who performed the operation or a surgeon who is familiar with details of the case. The specialty requires dedicated training to master its unique body of knowledge. Certification through the ABTS is under consideration.

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