

Guidelines for medical technology in critical care

Technology Subcommittee of the Working Group on Critical Care, Ontario Ministry of Health

Objective: To examine the current status of technology in critical care medicine and to present guidelines for technologies commonly used in Ontario critical care units.

Data sources: A computerized search of the medical literature, interviews with relevant people and a review of existing guidelines or standards were conducted.

Study selection: Nonrandomized trials and retrospective reviews were included because of a paucity of prospective randomized controlled trials.

Data extraction: Technologies were assessed by individual committee members. The validity of the technologies was compared with accepted standards when available. All published clinical data were used to assess efficacy.

Data synthesis: After review of the data, discussion papers on ventilation, and electrocardiographic, hemodynamic and intracranial pressure monitoring were written by committee members and then reviewed by the subcommittee as a whole. For each technology an attempt was made to match need with the patient classifications of the Working Group on Critical Care. Critical care guidelines were then developed through the use of the nominal group and Delphi consensus-gathering techniques. The guidelines were reviewed by external experts.

Conclusions: These guidelines should help in assessing quality assurance and the resources necessary for critical care. Also, they should enable health care providers and hospital administrators to make better decisions when acquiring critical care technology. Since the guidelines represent the current state of knowledge there must be a continuing assessment of the technology and review of the guidelines.

Objectif : Examiner l'état actuel des techniques de la médecine des soins critiques et présenter les lignes directrices pour les techniques habituellement utilisées dans les services de soins critiques en Ontario.

Sources des données : Recherche informatisée dans la littérature médicale, entrevues avec les intéressés et examens des lignes directrices ou des normes actuelles.

Sélection des données : Les études non randomisées et les examens rétrospectifs ont été inclus en raison de la rareté des études prospectives randomisées et contrôlées.

Saisie des données : Les techniques ont été évaluées par chaque membre du sous-comité. La validité des techniques a été comparée avec les normes établies le cas échéant. Toutes les données cliniques publiées ont été utilisées pour évaluer l'efficacité.

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The views expressed in the article are not necessarily those of the Ontario Ministry of Health.

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Synthèse des données : Après examen des données, des documents de travail sur la ventilation, l'électrocardiographie, l'hémodynamique et la surveillance de la pression intracrânienne ont été rédigés par les membres du sous-comité et ensuite révisés par le sous-comité dans son ensemble. Pour chaque technique, on a essayé d'agencer le besoin avec les classifications de malades du Groupe de travail sur les unités de soins critiques. Des lignes directrices sur les soins critiques ont ensuite été élaborées au moyen d'un groupe nominal et de techniques Delphi pour créer le consensus. Ces lignes directrices ont été examinées par des experts en provenance de l'extérieur.

Conclusions : Ces lignes directrices devraient faciliter l'évaluation de l'assurance de la qualité et les ressources nécessaires aux soins critiques. Elles devraient aussi permettre aux intervenants en soins de santé et aux administrateurs hospitaliers de prendre de meilleures décisions lorsqu'ils se dotent de techniques de soins critiques. Puisque ces lignes directrices représentent l'état actuel des connaissances, on doit procéder à une évaluation permanente des techniques et à une révision incessante des lignes directrices.

The rapid growth in health care technology has been blamed in part for escalating health care costs. In no area is this problem felt to be greater than in critical care, which makes use of 5% of all hospital beds but consumes 20% of the hospital budget. The need to review existing technology — much of it unproven — was identified by the Ontario Ministry of Health Working Group on Critical Care; it in turn appointed the Technology Subcommittee for the purpose.

The subcommittee reviewed the Canadian federal guidelines on intensive care¹ and coronary care² units, the US guidelines of the Society of Critical Care³ and the accreditation guidelines from the Canadian Council on Health Facilities Accreditation.⁴ We felt that each of these bodies represented different constituencies, reflected opinions that were 2 or more years out of date, failed to acknowledge the sophistication and complexity of newer technologies and did not have well-documented evaluation processes.

We present the guidelines proposed by the Technology Subcommittee of the Working Group on Critical Care. These are the culmination of a lengthy

process of literature review, technology assessment and the use of nominal group (Delbecq)⁵ and Delphi⁶ techniques for consensus and external peer review. The guidelines represent a multidisciplinary opinion on present practices in Ontario.

Methods

The development of group consensus on critical care guidelines went through several stages. First, subcommittee members were chosen because of their expertise (i.e., in medicine, nursing, administration and bioengineering) and their geographic location in order to achieve consensus from a multidisciplinary group that reflected the various levels of care in Ontario.

Second, current technologies were identified for study and analysis. Literature searches were performed on each; nonrandomized trials and retrospective reviews were included because of a paucity of randomized controlled trials. Discussion papers were prepared by individual members for subsequent group discussion. These discussion papers

Table 1: Summary of guidelines for critical care technologies by patient classification and level of need

Technology	Patient classification;* level of need†			
	A	B	C	D
Ventilation	E	E	E§	E§
Airway	E	E	E	E
Manual resuscitation	E	E	E	E
Endotracheal tube	E	E	E	E
Nonconventional ventilation‡	O	O	N	N
Electrocardiographic monitoring	E	E	E	E
Hemodynamic monitoring	E	E	D	N
Intracranial pressure monitoring	O	O	N	N

*For descriptions of patient classifications see the text.

†E = essential, D = desirable, O = optional, N = not needed and U = unknown.

‡Not essential as a minimum guideline but may be used when case mix warrants and expertise is available. Used in research at present.

§Portable, for short-term resuscitation and available in facility. The facility should have the capability to support artificial ventilation.

consisted of the known assessment of each technology, including its capability, potential range of use, accuracy or efficacy, impact on health care providers and effect on clinical outcome.⁷ If available, cost-benefit analyses were included. All of us reviewed and critiqued the discussion papers.

Third, we agreed on a format for the guidelines. Agreement was reached through the nominal group technique to include ventilation and electrocardiographic, hemodynamic and intracranial pressure monitoring. For each of these we attempted to match

need with the following patient classifications, developed by the Working Group on Critical Care.

- A patients: these patients have multisystem organ failure and require comprehensive critical care management and life-support care from a multidisciplinary team of experts. The most advanced critical care technologies are available to these patients.

- B patients: these people have multisystem organ failure and require all the accepted strategies for comprehensive critical care management.

- C patients: these patients have single-system

Table 2: Guidelines for specific features of ventilation by level of need

Feature	Level of need		
	Essential	Optional	Unknown
Training	X		
Manual resuscitation	X		
Endotracheal tube			
Single lumen	X		
Double lumen		X	
Airway	X		
Conventional ventilation	X		
Nonconventional ventilation*		X	
Portable equipment		X	
Disconnect alarm	X		

*Nonconventional modes of ventilation are extracorporeal membrane oxygenation, high frequency ventilation and cardiopulmonary bypass ventilation.

Table 3: Guidelines for specific features of electrocardiographic monitoring by level of need

Feature	Level of need		
	Essential	Optional	Unknown
Training	X		
Unobstructed viewing	X		
Ability to monitor from another patient's bedside		X	
Parameters			
Heart rate	X		
Arrhythmia detection	X		
ST-segment analysis		X	
Ability to be upgraded to more complex system	X		
Measurement capabilities			
No. of leads			
One	X		
Two or more		X	
Alarms			
Visible and audible	X		
Selectively programmable*	X		
High/low	X		
Hard-copy capability	X		
Editing capability		X	
Trending capability of standard arrhythmias		X	
Classification of arrhythmias		X	
Ability to be upgraded	X		
Remote terminals		X	

*Asystole and ventricular fibrillation alarms must not be programmable.

organ failure and may be at risk for multisystem organ failure. Comprehensive monitoring and management generally focus on one organ system. Physicians, nurses and allied health care workers with the appropriate expertise in the organ system (e.g., coronary care and burns) are required.

- D patients: at risk for single or multisystem organ failure these people need limited critical care management, primarily noninvasive monitoring. Typically, this type of patient is located either close to a ward nursing station for close monitoring or in a

low-intensity facility for stabilization before transfer to a higher-intensity facility.

We then attempted to determine whether the technologies were essential, desirable, optional, unnecessary or of unknown benefit and whether each of the various features or capabilities of the technology were essential, optional or of unknown importance.

To arrive at our assessments we used a combination of nominal group and Delphi techniques.^{5,6} The nominal group (Delbecq) technique is used in many consensus-gathering enterprises. It is a structured

Table 4: Guidelines for specific features of hemodynamic monitoring by level of need

Feature	Level of need		
	Essential	Optional	Unknown
Training	X		
Screen			
Multiple parameter displays		X	
Scale/calibration*	X		
Digital display	X		
Cursor device		X	
Remote terminals		X	
Parameters			
Two pressure channels†	X		
Cardiac output	X		
Mixed venous oxygen saturation (Svo ₂)			X‡
Pulse oximetry			X‡
Measurement capabilities			
Pressures			
Two channels	X		
Three or more channels		X	
Phasic	X		
Mean	X		
Editing capability	X		
Hard copy with scale		X	
Trending		X	
Alarms			
Visible and audible	X		
High/low	X		
Cardiac output			
Digital display	X		
Curve display	X		
Editing capability		X	
Trending		X	
Svo ₂			
Digital display	X		
Hard copy of tracing		X	
Alarms			
Visible and audible	X		
High/low	X		
Trending		X	
Pulse oximetry			
Digital display	X		
Hard-copy capability			X
Alarms			
Visible and audible	X		
High/low	X		
Trending		X	

*One or the other is essential.

†For arterial, pulmonary arterial, central venous and pulmonary capillary wedge pressures; specific use can be decided by attending physician.

‡Clinical utility is still unknown.

group process that encourages members to present their ideas to a group. The Delphi technique is also structured but relies on questionnaires completed away from the group, with subsequent feedback and re-evaluation. Each of us was then asked to complete tables assessing the level of need for the technologies. These responses were anonymous and were tabulated by the chairman and project officer; all major differences in assessment were resolved through discussion at a subsequent meeting.

The recommendations were reviewed by external experts. Minor criticisms were received and readily resolved. Finally, the recommendations were presented to the Working Group on Critical Care, and independent comment was elicited from each member through a questionnaire.

Outcome

After our careful review of the current situation we compiled a number of guidelines and recommendations (Tables 1 to 5). We recognized that issues such as human resources and education of personnel have an impact on decision-making about a technology. Our guidelines are based on the assumption that human resources are adequate in number and skills.

These are minimum guidelines that do not preclude the acquisition of more sophisticated technology. They should be updated at least every 3 years.

Discussion

The guidelines are of interest for several reasons. First, they reflect the sophistication and complexity of current technology. Second, the methods

we used to develop them represented our best efforts at technologic assessment based on literature review, group critique, the use of accepted consensus-gathering techniques and external peer review.

At present, bedside monitors with full capability cost over \$15 000. The capabilities of arrhythmia detection, ST-segment analysis, multiple pressure channel monitoring, pulse oximetry, noninvasive blood pressure monitoring, cardiac output determination and hemodynamic calculation are staggering. Physicians, nurses and hospitals have to make difficult decisions on how many of these features to purchase at a time of financial restraint. Our guidelines go beyond the simple question of whether pressure monitoring or cardiac output determination should be used, by suggesting how they should be done and what levels of sophistication are of proven or accepted value. We have also attempted to assess technologies whose cost-benefit ratio is unknown.

The assessment of technology is necessary in all medical fields, but few technologies are completely assessed before being introduced and diffused throughout the health care sector. For each technology covered in our guidelines literature reviews were performed and discussion papers written. We recognize that most technologies were incompletely assessed, but the current state of assessment was used in our consensus-gathering process.

Canadian federal guidelines were developed in 1986 through nominal group techniques by experts — primarily health care professionals — appointed by the Federal-Provincial Advisory Committee on Institutional and Medical Services. It is unclear how technologies were evaluated before this. Although helpful from a broad perspective in planning or evaluating an intensive care unit those guidelines do

Table 5: Guidelines for specific features of intracranial pressure monitoring by level of need

Feature	Level of need		
	Essential	Optional	Unknown
Training	X		
Monitoring sensors			
Ventricular catheter	X		
Subarachnoid bolt	X		
Epidural sensor	X		
Fontanelle monitor*	X		
Recording device			
Interchangeable with other units		X	
Continual digital readings	X		
Continual pressure wave displays	X		
Hard-copy capability		X	
Trending capability		X	
Scales on screen	X		
Alarms	X		

*For use in pediatric facilities.

not reflect present-day technologic complexities, especially in the area of monitoring.

The guidelines of the Society of Critical Care outline features of technology more thoroughly than the Canadian ones, but they represent the US perspective, which is not always relevant to Canadian practices. The methods for developing the US guidelines involved nominal group and Delphi techniques. Formal assessments were not performed.

We strongly believe that our guidelines will benefit decision-makers and practitioners in critical care. The guidelines are up to date, comprehensive and reflective of the current practices in all Ontario hospitals — teaching and nonteaching, urban and rural, and those in the North. The processes used to develop the guidelines were as rigorous and as scientific as possible at this time. As the assessment of technology becomes more comprehensive such objective methods as randomized controlled trials will be valuable in developing guidelines.

In summary, the guidelines should help in assessing quality assurance and the resources necessary for critical care. In addition, they should enable health care providers and hospital administrators to make better decisions when acquiring critical care technology. Since these guidelines represent the current state of knowledge there must be a continuing assessment of the technology and review of the guidelines.

The Working Group on Critical Care was established and funded by the Ontario Ministry of Health.

References

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Conferences

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July 14-19, 1991: 32nd Annual Institute on Addiction Studies

Hamilton, Ont.

Karl Burden or Michelle Schaerf, Concerns Canada, 200-11 Progress Ave., Scarborough, ON M1P 4S7; (416) 293-3400, fax (416) 293-1142

July 14-20, 1991: 1st World Congress on Wilderness Medicine (7th Annual Meeting of the Wilderness Medical Society and 1st in a series of quadrennial international events)

Chateau Whistler Resort, Whistler, BC

Dr. Douglas A. Gentile, Vanderbilt University, 243 Medical Center South, Nashville, TN 37212, (615) 343-4836, fax (615) 343-6873; or Dian M. Simpkins, Wilderness Medical Society, PO Box 397, Point Reyes Station, CA 94956, (415) 663-9107

July 19-21, 1991: 14th National Conference on Pediatric/Adult Allergy and Clinical Immunology

Toronto
Rayna Saville, Pediatric Continuing Medical Education, State University of New York at Buffalo, Children's Hospital, 219 Bryant St., Buffalo, NY 14222-2099; (716) 877-7965, fax (716) 877-6729

July 19-21, 1991: International Lactation Consultant Association Annual Conference

Hotel Inter-Continental, Miami

Terry Bloomingdale, conference registrar, 2311 E State St., Rockford, IL 61104; (815) 398-0296

July 24-26, 1991: Annual International Congress of the British Association of Paediatric Surgeons

Budapest
Executive secretary, c/o Royal College of Physicians and Surgeons of Edinburgh, Nicholson Street, Edinburgh EH8 9DW, Scotland

July 31-Aug. 4, 1991: International Doctors in Alcoholics Anonymous 42nd Annual Meeting

Hyatt Regency Hotel, Vancouver

CME credits available upon request.

IDAA 1991, All Destinations Travel, 1290 Homer St., Vancouver, BC V6B 2Y5; (604) 683-6966, fax (604) 683-7685

Aug. 4-8, 1991: American Institute of Biological Sciences Annual Meeting

Hotel Hilton Palacio del Rio, San Antonio, Tex.

Meetings Department, 730-11th St. NW, Washington, DC 20001; (202) 628-1500

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