ICU MANAGEMENT

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The Official Management and Practice Journal

Conflict Management

PLUS:

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- SPECIAL FOCUS ON HYPOTHERMIA
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Conflict Management

Conflict arises in all fields and workplaces and in **ICU Management** we are not immune to issues of disagreement. On the contrary, our unique role as physicians to patients and managers to staff puts us in a seemingly inevitable and continuous environment of conflict. Whether we must mediate a disagreement between doctors and nurses in our departments, or resolve a dispute involving the course or termination of care with a patients' family, we often need to manage difficult situations in the absence of clear guidelines to lead our decision making process.

In this issue of **ICU Management**, we tackle the ethics and resolution practices involved with the broad range of disputes we encounter on a daily basis. Dr. Hawryluck and Dr. Lawless from Toronto General and St. Michaels Hospitals in Toronto, Canada outline ethical principles related to development of conflict resolution policy, while Senior Policy Analyst Nathalie Danjoux explains common causes and recommendations for preventing conflicts in interactions with patients and their families. Kathleen Bartholomew utilises her experience on the other side of the spectrum to advise on best practises for avoiding and resolving conflicts between nurses themselves as well as between nurses and doctors.

In order to continue to provide articles of innovative techniques in critical care, we have included a Special Focus on Hypothermia in this issue of ICU Management. Prof. Polderman of University Medical Centre in Utrecht, The Netherlands discusses the cost-effectiveness of induced hypothermia and Prof. Idrissi of University Hospital Brussels, in Belgium explores the limits of the use of hypothermia in his articles on mild hypothermia as treatment in both cerebral ischaemic insult and cardiac arrest. Dr. Gene Sung of the University of Southern California in Los Angeles, California summarises promising research with respect to the use of hypothermia in acute ischaemic stroke.

Drs. Rothen and Mende have contributed an enlightening and timely article on special considerations in caring for obese patients in the ICU for our Management focus. We turn our attention to Norway for our Country Focus, where Dr. Hans Flaatten chronicles recent ICU cases that have captured the public's interest and stimulated a myriad of changes in ethical and decision-making guidelines in futility cases. In addition, Dr. Nils Smith-Erichsen, an ICU consultant, delves into his personal experiences and opinions about the challenges and advantages of working in a Norwegian intensive care in this issues' interview.

Be sure not to miss the preview for this year's Society of Critical Care Medicine's annual congress in Hawaii followed by an update on the highly anticipated preliminary results of the Epic II Study.

As ICU managers, we are continually faced with obstacles that stretch our skills as clinicians and challenge the limits of our management expertise. We hope that our focus on conflict management–both in terms of methods of prevention and policies for resolution will help you to overcome disputes that you confront on a daily basis.

Jean-Louis Vincent
Head, Department of Intensive Care, Erasmus Hospital, Free University of Brussels, Belgium

Letters to the Editor & Requests for References Cited in ICU Management
editorial@icu-management.org

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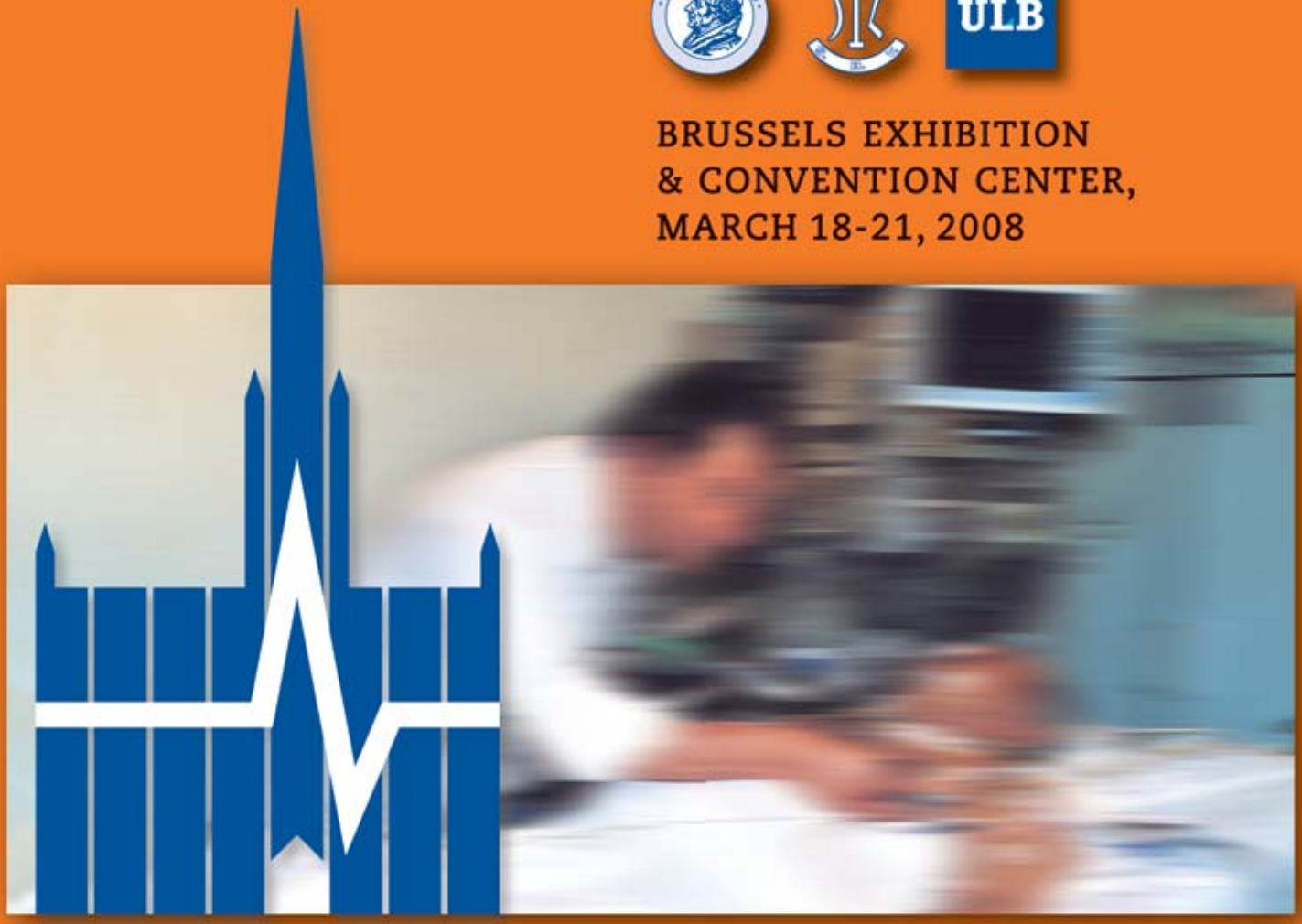

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EDITORIAL

Conflict Management	J.-L. Vincent	1

NEWS 4

COVER STORY: CONFLICT MANAGEMENT

Ethics in the ICU: Can Policies Help Resolve Conflicts?	L. Hawryluck, B. Lawless	6
Managing RN/RN and RN/MD Conflict in the ICU: Productive Ways of Communicating	K. Bartholomew	8
Conflicts in the ICU: Management and Resolution Practices	N. Danjoux, L. Hawryluck	10

SPECIAL FOCUS ON HYPOTHERMIA

Mild Hypothermia as Treatment in Cerebral Ischaemic Insult	S. Idrissi	12
Induced Hypothermia and Fever Control in Neurological Injury: Cost-effectiveness Issues	K. Polderman	16
Hypothermia as Treatment in Cardiac Arrest: Pathophysiology	S. Idrissi	18
Hypothermia in Acute Ischaemic Stroke	G. Sung	21

PRODUCT COMPARISION: DEFIBRILLATORS

Defibrillators (ECRI Europe)		25

MATRIX FEATURE

Failed Intubation in a Paralysed Patient	T. Heidegger, H. Gerig	30
Quality Improvement In Intensive Care Units: ICU Physicians Ideally Positioned to Lead the Way	L. Chelluri	31
Extended Duration Workshifts: The Impact on House Staff and Patient Safety	S. Mountain, B. Quon, N. Ayas	32
Issues in Medical Education: Acute Care Undergraduate Teaching	M. Alansari	34

MANAGEMENT

Caring for the Obese Patient: Special Considerations in the ICU	H. Rothen, L. Mende	36

COUNTRY FOCUS: NORWAY

An Overview of Healthcare in Norway	B. Eggen	38
Critical Care in Norway	H. Flaatten	39
Professional Life in Norwegian Intensive Care	P. Klepstad	40

VIEWS & INTERVIEWS

An interview with Nils Smith-Erichsen	S. Scharff	41

CONGRESS PREVIEW

SCCM's 2008 Congress	S. Bernard, L. Brusco H. Hirasawa, R. Kacmarek	44

EPIC II: PRELIMINARY RESULTS

The EPIC II Study	J.-L. Vincent	46

AGENDA 48

ICU Management is the Official Management and Practice Journal of the International Symposium on Intensive Care and Emergency Medicine and was previously published as Hospital Critical Care.

Letters to the Editor & Requests for References Cited in ICU Management
editorial@icu-management.org

News Europe

Heart Disease: Europe's Number One Killer

www.europarl.europa.eu

The European Parliament has called on the EU Member States and the European Commission to tackle today's biggest killer in Europe: Cardiovascular disease. MEPs believe prevention strategies, public awareness campaigns, and the promotion of healthy lifestyles is urgently needed.

Cardiovascular disease accounts for 1.9 million deaths each year, i.e. 42 percent of all fatalities in the EU, generating costs of €169 billion, of which €105 billion are for treating the condition in the EU and €64 billion are attributable to lost productivity and the cost of informal care. No better illustration is needed of the economic value of preventive healthcare.

Parliament asks the Commission to bring forward a policy recommendation:

- To promote regular exchanges of experience and data between all those involved in combating these diseases and
- to encourage tobacco and alcohol controls, better dietary habits and more physical activity, with a view to preventing obesity and high blood pressure.

Member States are urged to review national public health strategies so as to include health promotion as well as early high-risk management strategies on cardiovascular health, and to develop health impact assessments to measure the burden of these ailments on national healthcare systems.

It also calls on the EU "to encourage the equipment of large public spaces, such as railway and metro stations, airports and stadia, with pre-hospital system care such as early defibrillation for victims of cardiac arrest".

News Industry

PiCCO$_2$ Provides Fast Decision Support for the Therapy of Critically Ill Patients

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PULSION Medical Systems have started the implementation of the PiCCO$_2$ system in leading hospitals across Europe after successful CE-Approval.

The PiCCO$_2$ offers a unique combination of parameters, providing a complete overview of the cardiovascular system and the haemodynamics of patients. The different display options such as SpiderVision enables the user to detect at a glance whether the patient is stable, unstable or critical. Until now the parameters for oxygen saturation and consumption and those for blood flow, blood volume and organ functions have been provided by two separate devices. The PiCCO$_2$ combines both technologies.

Grant in the US of a Patent for Setting and Adjusting of a Cardiac Biventricular Pacemaker

www.lidco.com

LiDCO, the UK based, AIM-quoted cardiovascular monitoring company, announced that it has received confirmation of the approval of its US Patent application for a new method and apparatus for optimally adjusting a biventricular pacemaker – used for the treatment of congestive heart failure (CHF). The method involves the measurement of changes in certain haemodynamic parameters (arterial pulse pressure and stroke volume) that have been shown to reflect improvements in the heart's pumping action (ventricular performance). Using the LiDCOplus Monitor these parameters are measured minimally invasively and beat-to-beat.

Arrow International and Johns Hopkins Awarded Judgement Against Datascope in Patient Litigation

www.arrowintl.com

A judgment was awarded to Johns Hopkins University and Arrow International, Inc. in their patent infringement lawsuit against Datascope Corp. on Friday, June 15, 2007, in the United States District Court in Baltimore, Maryland. Johns Hopkins and Arrow had brought suit against Datascope for infringing patents relating to the Arrow-TrerotolaTM Percutaneous Thrombolytic Device (PTD®), a device used by interventionalists for treating haemodialysis patients. The Baltimore jury found that the Datascope ProLumen device infringed three patents owned by Johns Hopkins and licensed by Arrow, and upheld their validity. The jury also awarded damages amounting to an 18% royalty on Datascope's sales of the infringing device. Johns Hopkins and Arrow have asked the court to issue a permanent injunction against Datascope's sales of the ProLumen.

VIASYS Unveils the BreatheX™ Journey

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Constructed to be small and unobtrusive, the new BreatheX™ Journey CPAP from VIASYS is powered by a rechargeable battery that will provide 11 hours of use at 10 cm H2O. Providing CPAP pressures from 5 to 12 cm H2O, the BreatheX™ Journey features ramp and altitude compensation and includes a 72 inch hose, which allows the system to be positioned in the most comfortable or convenient position. Compact and mobile, the CPAP system is compatible with a range of masks and nasal pillow systems including The Advantage Series™ Nasal and Full Face Masks and SNAPP X Direct Nasal Interface, all of which are also made by VIASYS.

News Research

Genes and Drugs Team up to Lower Blood Pressure

www.biomedcentral.com/bmcmedgenet

Patients with high blood pressure respond very differently to antihypertensive medication, making treatment selection tricky for physicians. But new research published in the online open access journal, BMC Medical Genetics, pinpoints a number of gene-drug interactions that could allow medication to be tailored to individual patients based on their genetics.

The US research team studied siblings with hypertension by examining blood pressure readings and details of their drug regimens. Using these data, the authors found a new set of single nucleotide polymorphisms (SNPs) on the adducin 2 (ADD2) gene that may influence the regulation of blood pressure among people with hypertension.

Three SNPs were associated with differential blood pressure responses in beta-blocker users versus diuretic users while two other SNPs were associated with differential responses in renin-angiotensin-aldosterone system (RAAS) inhibitor users versus diuretic users. The findings also provide initial evidence that the effects of genetic variation on blood pressure in people with untreated hypertension may be very different compared with those taking medication. Although the authors looked at individual SNPs, it is also likely that SNPs interact.

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Ethics in the ICU

Can Policies Help Resolve Conflicts?

Laura Hawryluck MSc (Bioethics), MD, FRCPC
Associate Professor
Critical Care Medicine
University Health Network
Toronto General Hospital
Toronto, Canada
laura.hawryluck@uhn.on.ca

Bernard Lawless MD, MHSc, CHE, FRCSC
Provincial Lead
Critical Care and Trauma,
Ontario Ministry of Health and Long-term Care
Lecturer
Department of Surgery
St. Michaels Hospital
Toronto, Canada
lawlessb@smh.toronto.on.ca

Decisions to admit a patient to the Intensive Care Unit (ICU), to continue or withdraw potentially life-sustaining treatments, are inherently challenging due to scientific uncertainty, ongoing advances in knowledge and technology and our limited abilities to accurately predict individual patient outcomes. The manner in which such technology is perceived in increasingly multicultural societies and, how this diversity of beliefs affects communication and decision-making, challenges the knowledge and understanding of front-line clinicians. The need for broad-based and respectful approaches to critical care delivery and for conflict resolution is becoming essential in the context of appropriate utilisation of resources. The question is, can policy help?

Ethical Principles for Policy Development

To be effective, any conflict resolution policy needs to have a clear and specific purpose. In the ICU, this purpose is to develop a treatment plan establishing clear goals of patient care, using impartial, respectful and transparent processes to resolve disputes in a timely manner. Some guiding ethical values to consider in the development of such policies include autonomy, justice, flexibility, accountability and public interest.

Autonomy includes consideration of the patient's wishes, beliefs and rights to make healthcare choices. It calls for collaboration, the exploration of common ground and appeals to participants to consider the "costs" of ongoing conflict. Principles of justice are essential to ensure that the process is fair, open, and transparent and that participants are, and perceive themselves to be, treated fairly. Moreover any policy must respect current legal frameworks. Flexibility is a value particular to a multicultural society that reflects the many paths that can be used to achieve resolution. Accountability, as with autonomy, mandates that participants are responsible for the outcomes of any resolution process. Accountability also reflects the value placed by the hospital administration and the broader public on achieving successful outcomes and providing high quality patient care. Indeed the best conflict resolution policies would explore how the entire organisational structure of the hospital can prevent conflicts with patients and families and among healthcare teams. Finally, the ethical dilemmas and quality of care concerns involved almost always engage broader public interest. Crucial to the notion of a "just society" and "equitable access to high quality healthcare", there is a need in any developed policy to balance respect for individual autonomy and multicultural and religious diversity with the need to ensure appropriate access to appropriate care.

Existing Policies

In the past few years, the ethics sections of Canadian, American and European Critical Care Societies have issued position statements describing the appropriate use of critical care services. These papers describe the goals of this field - to support a patient through an acute, potentially reversible, life-threatening illness and provide broad guidance on medical diagnoses, physiological and haemodynamic criteria that require the specialised monitoring, skills and technologies of an ICU environment (Thompson et al. 2003). Yet existing policies fall short of meeting the pressing need of front-line clinicians and of answering the fundamental question that gives rise to conflict situations.

Described best practices for conflict resolution include facilitating discussion and elucidating goals of treatment, listening to and addressing the concerns of patients and families, as well as clarifying misinformation and misunderstandings. It is often times useful to involve and enlist other members in the multidisciplinary ICU team such as ICU nurses, social workers, bioethicists and pastoral care services or community religious leaders in resolution efforts.

Existing policies recognise the unique skills of each member of the ICU team and how they may be helpful in building understanding and discovering new courses of action. A second medical opinion is recommended to ensure issues of diagnosis, prognosis, treatment options and recommendations are reviewed. Finally current policies for conflict resolution clearly describe the professional obligations to seek resolution and emphasise that while patient care responsibilities may be transferred to another, they cannot be abandoned.

Challenges in Clinical Practice

Despite the application of such best practices, it remains unclear how many conflicts are deemed intractable. Second opinions may be difficult to obtain in smaller communities. Family members may have concerns that second opinions will be biased. These concerns may be valid as intensivists are apt to call upon colleagues with whom they have a good relationship. Moreover, often those providing the second medical opinion do not interact with the family and a potentially important opportunity to help resolve the conflict is thereby lost.

How Can Policies Help Conflict Situations?

Increase Access and Utilisation Policies' Clarity and the Quality of Guidance Provided

Any described process for conflict resolution is usually found as part of ICU policies on admission, discharge and triage. Such policies need first to refocus on the development of a consistent standard of care for access and utilisation that respect individual autonomy, multicultural and religious diversity, balanced with the equally vital need to ensure respect for the public's interest in appropriate access to a limited critical resource.

Promote Development and Communication of Goals of Care

Policies regarding critical care access and utilisation should promote open communication and means to develop clear treatment goals with the patient or their substitute decision-maker in collaboration with involved subspecialty teams. Policies should describe processes to re-evaluate the patient's condition and the effectiveness of potentially life-sustaining treatments at clear time intervals or when the clinical condition changes. In situations of uncertainty, policies should detail the role of a trial of therapy with clear goals and reasonable time frames set a priori.

Once the goals of treatment have been agreed upon with a patient they must be adhered to unless there is a change in the patient's diagnosis. The policy needs to ensure that changes in the most responsible ICU physician do not result in a drastic change of treatment plan.

Broaden Stakeholder Engagement

Develop processes to promote skilled and open communication of access and utilisation policies and to educate patients, substitute decision-makers and key stakeholders (Gibson et al. 2005) on what ICU care entails and to provide input on what the standard of care is for its use.

Mandate Consistent Fair and Transparent Second Opinion Processes

Policies should describe who can give a second opinion in ways that promote transparency and fairness and best practices regarding how a second opinion should be provided and documented. Furthermore, the role of the second intensivist towards the patient and substitute decision-maker should be delineated. If the policy mandates that the second intensivist meet with the patients/substitute decision-maker it would ensure their active participation in the consultation process and potentiate resolution with the development of reasonable expectations, goals and treatment plans.

Describe Clear Processes for Conflict Resolution that Support Front-Line Clinicians

Current policies outline a list of professionals who may be consulted in order to help achieve resolution. Such involvement may be effective, or it may serve to further entrench positions. As their final recommendation, policies often suggest transferring care of a patient to another hospital in the case of intractable conflict. In practice, such an option rarely exists and serves only to leave clinicians feeling unsupported. Policies would be greatly improved if instead they explored how organisational structures could support conflict resolution. Such support is particularly important if legal recourses are to be undertaken.

Conclusion

Carefully developed policies that delineate a clear standard of critical care utilisation, promote processes to develop and communicate reasonable goals of care and describe practical processes to resolve disputes can improve the quality of care of any given patient. Limited critical care resources mean that not every patient and their family can receive every treatment they desire despite potential benefits. To provide practical guidance, policies must not shy away from providing ethical and legal frameworks and standard of care criteria to support clinicians and families facing difficult decisions. Such support can be an important step in preventing conflicts from arising. A system-wide approach to policy development and implementation is required otherwise such policies, despite being practical will still sit on the shelves of the ICU. ■

Managing RN/RN and RN/MD Conflict in the ICU

Productive Ways of Communicating

Kathleen Bartholomew
Consultant Nurse
Author "Ending Nurse-To-Nurse Hostility" (2006)
Seattle, US
kathleen.bartholomew@swedish.org

Managers are in a pivotal position to decrease conflict. By their response, or lack of response, they informally create the code of behaviour for the unit. Staff members are always watching: What did the manager do when the physician yelled at the nurse? What action did the manager take after a nurse complained that a co-worker was sabotaging his or her reputation? The way these challenges are addressed on a daily basis not only forms the code of behaviour, but also essentially governs the way staff address conflict on the unit.

Significant research exists to confirm the damage caused by relationship conflict in healthcare. Relationship conflict affects morale, satisfaction and quality of care. Nurses who report the highest degree of conflict also experience the highest degree of burnout. This data is no surprise to managers who spend 30 - 40% of their workday dealing with some form of workplace conflict. Because resolving conflict can be exhausting and time-consuming, many managers tend to ignore nurse-to-nurse conflict, or act like a third party and negotiate compromise in order to end an energy-draining situation quickly. But neither of these strategies is effective. What is the best way to manage nurse-to-nurse and nurse-to-physician conflict in the ICU?

Nurse-to-Nurse Hostility

Hostile behaviours, whether overt or covert, are extremely hurtful. Gestures such as raised eyebrows, cliques, sarcasm and "eye-rolling" have a profound and detrimental effect on teamwork, retention, quality, safety and satisfaction and are the source of much conflict. Unfortunately, in the culture of nursing, these behaviours are viewed as "normal". Nurses do not recognise the impact this type of horizontal hostility can have, nor do they possess the skills necessary to confront each other.

Nurse-to-nurse conflict is seldom resolved as nurses' most common style of communication is passive-aggressive, and any conflict is typically dealt with by avoidance. This can undermine the positive relationships necessary for a healthy workplace. In addition, when workplace pressure escalates, people in a state of defensiveness tend to revert back to their old styles of communicating – even if they have been given the tools to communicate effectively. Therefore, the responsibility to constructively deal with conflict and create healthy relationships falls to the unit manager.

One of the most vulnerable populations is new nurses, of which up to 60% leave their first position within the first 6 months because of some form of lateral hostility. In a global nursing shortage, this statistic is particularly disheartening. However, research shows that awareness of horizontal hostility allows new grads to depersonalise the attack and continue to learn.

Solutions to Reduce Nurse-to-Nurse Conflict

In order to change the culture of a unit, the manager must set a new standard and then hold staff accountable to it. It's not easy to spot, act upon, and follow up with staff whose subtle acts of antagonism alienate co-workers, when you're juggling other more immediate priorities. But investing in a campaign to end negative and destructive behaviours has a tremendous payoff: Retention, healthy relationships, and cohesive teams.

What works? Managers who encourage nurses to resolve their own issues and who provide education on communication and confrontation skills will find that the investment far exceeds their expectations. A sense of powerlessness can be a major cause of conflict. Destructive attitudes such as "that's the way it is around here", or "nothing will change" are evidence of powerlessness. Staff members who lack authority or power will act out their frustrations toward each other. In response, the most important action a manager can take is to empower staff to take care of their own interpersonal relationships.

Encouraging Independent Resolution

Because managers are not omnipresent, it is critical to first ensure that head nurses possess the skills to confidently address conflict on the unit before initiating staff education. Then, provide education on conflict management and assertive communication for staff or incorporate these classes as part of a staff education day.

Post a flyer that defines horizontal hostility and reminds staff of the behaviours that are unaccept-

able. If a staff member comes to you for help in resolving an issue, offer to role-play the conversation and provide coaching. Set the expectation that they will solve the problem and that your role is purely supportive. Another proven strategy is to ask staff to develop their own unit-based philosophy, which clearly states unit behavioural standards. Nowhere is guidance more needed than in

"60% of new nurses leave their first position because of some form of lateral violence"

leading staff to realise that they themselves have the power to create a work environment where every single team member is valued, appreciated and acknowledged.

The Role of the "Silent Witness"

One of the most effective strategies in dealing with nurse-to-nurse conflict has been to teach staff about the role of the "silent witness". As one nurse recently realised, "I've never said anything bad about another nurse in my whole career, but on the other hand, I stand there and listen while one nurse is talking badly about another." Witnessing gossip or backstabbing is detrimental to the psychological safety of the workplace. As managers, we can take away the secrecy and shame involved by openly discussing damaging behaviours, stopping the pretence that they are harmless and can be ignored, and setting the expectation that it is unprofessional and harmful to stand by and be a silent witness while another nurse is being criticised.

RN/MD Relations

Poor MD/RN relations inhibit communication and are detrimental to patient safety, teamwork and satisfaction. Because this has been directly linked to patient mortality, both parties have an obligation not to tolerate anything other than collegial relationships. In addition, poor physician-nurse relationships are a significant contributor to horizontal hostility because any group made to feel inadequate and powerless will always act out their frustrations towards each other. Manager intervention in holding physicians accountable for their role in any conflict is crucial if nurses are not to be negatively impacted by this sort of powerlessness.

Addressing Nurse-to-Physician Conflict

Begin by garnering commitment from the chief physician for the unit. Clearly state the impact of any poor relationships as well as the benefit of collegial relations (use specific examples). Communicate weekly with the chief, providing an update on your concerns and proposed solutions and arrange monthly standing meetings.

Empower staff to stand up for themselves and never make excuses for destructive or negative behaviours. Even the smallest of condescending mannerisms have a profound impact on the team. If staff cannot approach a physician directly, stand ready to approach the physician on their behalf. Physicians respond very positively to the words: "May I speak to you for a moment in private?" State the specific behaviour (e.g. raised voice) and its impact, while redirecting the conversation to the common goal: Safe and high quality patient care. In every single case of disruptive physician behaviour I have heard or witnessed, the physician truly does not realise the impact of his/her actions on staff and apologises immediately because these are unconscious learned behaviours.

Conclusion

A long history of power imbalance and inadequate communication skills in the healthcare culture manifests itself in nurse-to-nurse and nurse-to-physician conflict. Managers are in a pivotal position to engender new and more productive ways of communicating to resolve conflict in a positive way. Insist on professional behaviours at all times from the entire team. By refusing to let conflict go underground and empowering staff to resolve their own conflicts, managers have a powerful opportunity to create a new culture - one that is respected and acknowledged for its healthy collegial relationships. ■

Conflicts in the ICU

Management and Resolution Practices

Nathalie Danjoux, MSc
Senior Policy Analyst
Critical Care Secretariat
Toronto, Canada
nathalie.danjoux@uhn.on.ca

Laura Hawryluck MSc, MD, FRCPC
Associate Professor
Critical Care Medicine
University Health Network
Toronto General Hospital
Toronto, Canada
laura.hawryluck@uhn.on.ca

The complexities of decision-making and risk of conflict in ICUs will continue as demand for ICU care increases. Intractable conflict is resource intensive and emotionally and psychologically draining. Inconsistent responses to conflicts with patients and families often results in staff burnout (Poncet et al. 2007). Identifying and understanding causes of conflict and developing strategies to improve conflict resolution may decrease distress and improve patient care.

Causes of Conflicts

The most common conflicts in the ICU involve the goals of care and the role of life-sustaining interventions. These conflicts can occur between the ICU team and the patient's family, within the family itself and between or within healthcare teams (Studdert et al. 2003; Breen et al. 2001). Conflicts can occur when the designated substitute decision-maker makes judgements, influenced by cultural and religious expectations that do not reflect the patient's values or wishes. Intra-family conflicts challenge the relationship with caregivers, particularly when the law mandates that families make decisions by consensus. While mechanisms may exist to ensure that decisions be made in a timely manner, many healthcare providers are unaware of these options in their jurisdiction.

Conflicts within the ICU team may result when treatments do not seem to be in a patients' best interest, when risks outweigh the benefits or when it is clear that the goals of treatment will not be achieved, and yet families insist that treatments continue. Issues of limited resources are important, and often exacerbate such situations. Conflicts within and among healthcare teams regarding the care plan also have the potential to escalate conflicts with families. Subspecialty teams may have overly optimistic views of prognosis, fail to consider the patient's overall well-being or set unrealistic expectations of what life-sustaining interventions can achieve.

Methods used to Resolve Conflicts

Effective communication at various stages throughout the patient's stay in the ICU can help avoid conflict situations with family members. However, such communication is not always consistent, either in its frequency or content. Studies have reported an important shift in the language used as the ICU team reaches the conclusion that life-sustaining treatments should be withheld or withdrawn (Cook et al. 1999). The ethical concern with this approach is that personal and professional biases may unduly influence the language and timing of its use.

A physician may exercise caution by continuing life-sustaining interventions, even if treatment is believed to be against the patient's wishes. This type of conflict avoidance is often used in the hope that time may resolve the problem and families will realise the futility of continuing treatment. Compliance with families' wishes may result in continuing full treatment extending the patient's ICU stay until death ensues. A more paternalistic approach may involve providing fewer treatment choices for families. Such practices may be perceived as unethical (Asch, 1997), may not respect patients' preferences and values, and may result in family dissatisfaction (Azoulay et al. 2004).

When conflicts become intractable and a physician challenges a family's decision-making, support provided by their hospital is often variable, since it is viewed as an issue to be resolved by the individuals. Legal recourse can be seen as a difficult and unattractive option. Those who decide to challenge families by defending what they believe is best for the patient are often left with little if no legal support. Legal recourse is often avoided as it is a difficult, time-consuming and challenging process.

Recommendations for Conflict Situations

Focus on Prevention

Early, open and consistent communication with patients and families is essential. Clear and reasonable goals of care need to be established and documented when life-sustaining treatments are discussed. These goals should be reviewed at predetermined time intervals to evaluate response to treatment, or when/if complications arise. Early communication engages family members and helps empower their decision-making (Azoulay and Sprung, 2004).

Education and improvement in communication skills to facilitate shared decision-making and to address ethical and legal concepts are recommended. This is particularly important for referring clinicians, since decision-making prior to ICU admission often falls below ethical and legal

continued on p. 20

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Mild Hypothermia as Treatment in Cerebral Ischaemic Insult

Said Hachimi-Idrissi
MD, PhD, FCCM
Professor of Paediatrics
and Critical Care Medicine
Critical Care Department
and Cerebral Resuscitation
Research Group
University Hospital Brussels
Brussels, Belgium
said.hachimiidrissi@
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Historical Perspective of Hypothermia

The use of hypothermia in the clinical setting has it roots with the ancient Egyptians, Greeks and Romans. Hippocrates packed wounded soldiers in snow to reduce haemorrhage. In the early nineteenth century, Napoleon's surgeon Baron Larrey noticed that wounded soldiers who were near a fire died quicker that those who remained hypothermic. Clinical interest in protective hypothermia began in the 1930s and 1940s, with observations and case reports describing successful resuscitation in patients after plunging in cold water. During this period, Fay first reported positive results from cooling severe brain-injured patients (Tempel Fay, 1943). Other small clinical trials were carried out in the 1960s. Despite occasionally encouraging results in patients, moderate hypothermia (28°–32°C) was abandoned because of uncertain benefits and management problems. Nevertheless, 'hypothermia' as 'step H' was inserted into cardiopulmonary resuscitation (CPR) sequences in 1961. It was then believed that hypothermia must be moderate (less than 32°C) in order to be beneficial.

Experimental research into early moderate hypothermia after cardiac arrest (CA) was revived in the 1990s, when it was found to produce a significant benefit in reproducible outcome models in dogs. More important was the discovery of the potentially beneficial effects of protective/preservative mild cerebral hypothermia (32°–34°C), which is clinically safe, in contrast to moderate hypothermia (28°–32°C), which can cause arrhythmia, re-arrest, infection and clotting problems. In 1987, Hossmann reported that in cats with global brain ischaemia there was a correlation between mild (unintentional) pre-cooling and enhanced electroencephalogram recovery. Safar demonstrated a correlation between good cerebral outcome and mild (unintentional) hypothermia at the onset of ventricular fibrillation (VF) in dog models (Safar et al. 1990). Such studies in dogs confirmed the beneficial effect of resuscitative mild hypothermia on the brain after cerebral insult. However, the translation of data obtained from animal models to humans seemed difficult.

Brain damage related to ischaemia is not only an instantaneous event, but also a process of delayed neuronal death. Diminished cerebral blood flow initiates a series of events called neurotoxic cascades. Observations in animal models of global ischaemia have demonstrated that some hippocampal neurons deprived of oxygen do not die instantly. This delayed cell death has been also confirmed in humans. Although the mechanisms of hypothermia are not entirely understood, it seems that lowering the body temperature protects tissues deprived of oxygen.

Clinical Applications:

Cardiopulmonary Resuscitation

In 2002, two prospective randomised trials compared mild hypothermia with normothermia in comatose survivors out-of-hospital CA (Bernard et al. 2002; N.Engl.J.Med., 2002, Feb. 21). In patients who were successfully resuscitated after cardiac arrest due to VF, mild hypothermia reduced mortality rates and increased favourable outcomes. Based on these studies, in 2003 the International Liaison Committee on Resuscitation recommended that all unconscious adults with spontaneous circulation after out-of-hospital CA should be cooled to 32°-34°C for 12-24 hours when the initial rhythm is VF. Thus, resuscitative mild hypothermia should be used (Level of evidence: Class I) in a selected category of patients resuscitated from CA of cardiac origin, displaying a VF rhythm and with no refractory shock or persistent hypoxemia.

Traumatic Brain Injury (TBI)

In Traumatic Brain Injury (TBI) patients, the neurological damage occurring at the impact site is probably irreversible, however the subsequent brain damage secondary to cerebral oedema occurs hours or even days later. Cerebral blood flow (CBF) reduction secondary to cerebral oedema and increased intracranial pressure (ICP) further enhance the extent of brain damage. Another confounding problem is the presence of local hyperthermia areas in the brain, as brain temperature is up to 2°C higher than body temperature.

In 2001, Clifton et al. conducted a multicentric study including 392 patients from 11 US centres. Despite 48 hours of hypothermia, survival rates and neurological outcomes of patients were unchanged. Hypothermia was able to reduce ICP, but increased complications. The only group that seemed to benefit from hypothermia were those who were hypothermic at admission. In studies led by Polderman and Zhi, therapeutic mild hypothermia was effective in increasing the survival rate and reducing neurological disability. In both studies, hypothermia was maintained for a longer periods (115.2 h and 62.4 h respectively). In a meta-analysis, McIntyre et al. concluded that hypothermia could be effective in reducing mortality and improving neurological outcomes.

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It seems however, that while hypothermia is effective in reducing ICP (Level of evidence: Class I), reducing ICP does not necessarily improve survival rates or neurological outcomes. There is overwhelming evidence that the cooling period should be longer than in CA studies followed by a slow re-warming period. Routine use of hypothermia in TBI is not recommended (Level of evidence: Class III) however controlling fever seems mandatory (Level of evidence: Class IIa).

Stroke

In animal models, hypothermia has been used to protect the brain against focal ischaemia and human studies have yielded promising results so far. In all studies, the number of patients was small and the risk of complication was high, namely pneumonia. Animal studies and preliminary clinical studies have shown that hypothermia may be helpful to reduce infarct size and to improve neurological outcome, however the implementation of hypothermia as treatment for stroke still holds a Class III Level of evidence.

Subarachnoid Haemorrhage (SAH)

No major studies have been conducted concerning the use of hypothermia in Subarachnoid Haemorrhage (SAH). It seems that hypothermia reduces vasospasm, often complicating SAH. Initial results appear promising, but preliminary and inconclusive, therefore the Level of evidence is IV.

Neonatal Hypoxia–Ischaemia

The induction of hypothermia in infants and neonates is easier than the induction of hypothermia in adults, because infants and neonates have a larger surface relative to their body weight, and their thermoregulation is still underdeveloped. Feasibility studies conducted in neonates have shown that induced hypothermia was feasible and did not increase hypothermia-related complications, but the number of the patients was small and an improvement in the neurological outcome was still lacking. Larger randomised studies are needed to corroborate the use of induced hypothermia to prevent the ischaemic brain damage related to hypoxic–ischaemic insult (Level of evidence: Class III).

Paediatric Cardiac Arrest

Few paediatric cardiac arrest outcome studies include large number of patients; most evidence studies are retrospective and overall report low survival and poor neurological outcome of survivors. The Level of evidence is class III.

Other Potential Indications of Hypothermia

Based of the beneficial effects of hypothermia on ICP, resuscitative mild hypothermia is used to prevent ICP increases during hepatic encephalopathy. Other studies have suggested a beneficial effect of resuscitative mild hypothermia on status epilepticus and in acute disseminated encephalopathy. Some caution in the interpretation of these results and their implementation in general clinical use is warranted. Therefore, there is an urgent need for larger, controlled and randomised studies, but in the meantime the Level of evidence in the above-mentioned indications rates as class III.

Conclusion

It is clear that the use of resuscitative mild hypothermia as a neuroprotective tool will become more frequent, but physicians need to differentiate when such treatment is already proven and when it still a matter of debate or yet to be investigated. There is increasing evidence that resuscitative mild hypothermia will have some beneficial effect in mitigating brain damage after focal ischaemia such as stroke, TBI and SAH. However, several specific issues need to be resolved such as the peak window of time between the insult and the induction of hypothermia, optimal speed of induction, cooling duration and re-warming phase. ■

Level I	Recommended. Supported by at least two sufficient large randomised controlled clinical trials (RCCTs) with a correct randomisation procedure, double blinded protocol, the characteristics of the both groups are similar, and/or supported by a meta-analysis of RCCTs.
Level IIa	Acceptable and useful. Supported by at least one RCCT meeting the above criteria, and also supported by data from animal studies.
Level IIb	Fair to good acceptable evidence. Supported by one RCCT without evidence from other sources.
Level III	Unacceptable. Supported by a least one clinical non-randomised trial (cohort studies, case control, etc.)
Level IV	Indeterminate. Recommendations and opinions by expert and guidelines committee. Insufficient evidence to support a final class decision.

Table 1: Level of evidence

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Induced Hypothermia and Fever Control in Neurological Injury

Cost-effectiveness Issues

Prof. Kees H. Polderman
Vice Chairman
Department of Intensive Care
University Medical Centre
Utrecht, The Netherlands
k.polderman@umcutrecht.nl

In recent years, the issue of temperature management in critically ill patients, in particular those with neurological injuries, has gained increasing attention from the critical care community. An increasing body of evidence has shown that the development of fever in patients with various types of neurological injury is associated with an increased risk of adverse outcome. This has been shown most clearly in patients with ischaemic stroke, where the absolute risk of adverse outcome (death or permanent neurological impairment) increases by 2.2% for every degree of temperature increase. A similar increase in risk has been reported for post-cardiac arrest patients.

A link between fever and adverse outcome has also been reported in patients with other types of brain injury, such as traumatic brain injury, subarachnoid haemorrhage, and post-ischaemic injury following cardiac arrest. The fact that these associations persist after multivariate analysis suggests that the relationship is causal, i.e. that fever generates additional brain injury. This view is reinforced by observations from various animal experiments, which have shown that the extent of experimentally induced neurological injuries increases significantly if the animal is externally warmed. The risk conferred by fever appears to be independent of its cause; infectious fever, "central" (neurological) fever, and fever occurring during reperfusion injury are all linked to increased neurological injury.

> "Induction of mild hypothermia in the hours following injury can be neuroprotective"

Mild Hypothermia Benefits Certain Patients

If hyperthermia is harmful to the injured brain, it seems reasonable to assume that perhaps hypothermia could be protective. Indeed, it is becoming increasingly clear that induction of mild hypothermia (lowering of body temperature to between 32ºC and 34ºC) in the hours following injury can be neuroprotective, particularly in patients with post-anoxic injury. Hypothermia can be applied in numerous clinical situations; it has been used to decrease intracranial pressure (ICP) in patients with traumatic brain injury or ischaemic stroke, to mitigate myocardial injury following myocardial infarction, to reduce the inflammatory response in ARDS, and in numerous other situations.

However, positive effects of hypothermia have been most convincingly demonstrated in patients with global post-ischaemic brain injury. Two multicentred RCT's have shown improved outcomes associated with cooling in newborn babies with post-anoxic injury due to perinatal asphyxia; two RCTs have shown benefits in adult patients who remained comatose after a witnessed cardiac arrest, who had an initial rhythm of ventricular fibrillation (VF) or ventricular tachycardia (VT). Regarding the latter category, the European Resuscitation Council (ERC) has recently incorporated the use of induced hypothermia in selected patients following cardiac arrest into the ERC guidelines for resuscitation.

Growing Potential Indication for Induced Hypothermia

In the United States around 400,000 patients per year have a cardiac arrest. The number in Europe is similar. Between 20% and 38% of these patients have VF or VT as the first recorded rhythm. With appropriate emergency care around 70% of these patients can reach the hospital alive. Thus the group of patients with a potential indication for induced hypothermia is fairly large, particularly if all cardiac arrest patients admitted to the ICU were to be treated with induced hypothermia, as is the current policy in most units already using hypothermia as a medical treatment.

Calculations regarding the number needed to treat (NNT) to achieve one additional patient with favourable neurologic outcome have put this number at six. This figure is likely to be conservative, since in the above-mentioned studies the time intervals until initiation of cooling and achievement of target temperature were relatively long (eight hours in the largest adult study, six hours in the neonatal studies). The effects of hypothermia are likely to be greater if treatment is started earlier and cooling rates are faster.

Cost-effectiveness of Induced Hypothermia

Using the NNT of six as a basis for calculations, hypothermia treatment appears to be highly cost-effective in most settings. The prices of the currently available cooling devices range from €10.000 to €48.000, roughly comparable to the price of a mechanical ventilator. The efficacy of the different cooling devices varies considerably; efficacy can be judged based on:

- Speed of cooling;
- ability to maintain target temperature within a narrow range;
- ability to achieve slow and controlled re-warming; and
- absence or low frequency of side effects.

Furthermore, most cooling devices use disposable materials such as surface cooling pads or intravascular catheters to cool patients while one device uses partly re-usable cooling pads. The prices for these disposable materials range from €90 to €800 per patient.

Increased Workload Impacts Cost-effectiveness

The cost-effectiveness of cooling devices should not be judged solely on the basis of their purchase price and the price of the disposables. The associated workload of the medical and nursing staff is of equal and perhaps even greater importance. The amount and type of workload required for effective use of the cooling devices that are commercially available varies considerably. Which device is most appropriate and cost-effective, depends strongly on the specific setting.

In this regard, there will be considerable differences between low-volume and high-volume ICUs. High-volume units may simply be large hospitals with a large number of ICU beds, and/or units that treat many patients with hypothermia, perhaps for different indications. Units that use cooling devices for indications other than cardiac arrest, to treat patients with traumatic brain injury or to control fever in patients with neurological injuries, will usually need more than one cooling device, as these patients usually require treatments of longer duration.

Conclusion

Naturally, the costs per patient will vary considerably, and will be determined by the factors listed above. For high-volume units a relatively expensive device, with cheaper disposables, may be the best choice, whereas a low-volume unit may opt for a cheaper device with more expensive disposables. Depending on the volume of patients, the costs per patient may vary from €1000 per patient in a very low-volume setting to less than €200 per patient in high-volume units. With an NNT of six for one additional patient with favourable outcome, without an increase in the length of stay, it becomes clear that hypothermia is indeed one of the most cost-effective treatments currently available in intensive care.

> "Hypothermia is one of the most cost-effective treatments currently available in intensive care"

Even when using the price at the top end of the range above to calculate the overall costs, this would require an investment of €6000 to save one patient; the price per quality-adjusted life-year would still be less than €900. This compares highly favourably with many routine interventions in the critical care setting. As the actual price per patient will be significantly lower in most settings, cooling devices are undoubtedly a worthwhile investment. ■

For references please write to:
editorial@icu-management.org

Hypothermia as Treatment in Cardiac Arrest

Pathophysiology

Said Hachimi-Idrissi MD, PhD, FCCM
Professor of Paediatrics and Critical Care Medicine
Critical Care Department and Cerebral Resuscitation Research Group
University Hospital Brussels
Brussels, Belgium
said.hachimiidrissi@uzbrussel.be

Sudden cardiac arrest (CA) remains an unresolved public health problem. It is the major cause of death in western countries and some of the few survivors remain neurologically disabled. In this article, we explore the effects of sudden cardiac arrest on the brain, how pharmacology has failed to produce a reliable solution, and how hypothermia can offer an effective treatment in certain cases.

The Brain During Cardiac Arrest

During the initial no-flow period, loss of brain oxygen stores and unconsciousness occur within ten to twenty seconds. The 'four minutes limit' concept is supported by evidence that brain glucose and adenosine triphosphate (ATP) stores are depleted and the membrane pump is arrested within three to five minutes of complete ischaemic anoxia, at least in normothermic conditions. This ATP loss leads to membrane depolarisation with shift of the Ca_2+ into neurons, as well as an increase in the brain of the concentration of free fatty acids and extracellular concentration of excitatory amino acids (EAAs), particularly glutamate (Glu). These mechanisms seem partially responsible for the selective vulnerability of some neurons in certain regions, such as the hippocampus, neocortex, and cerebellum.

Neurotoxic cascades that are deleterious to the brain are provoked during the reoxygenation and reperfusion period, which are essential in restoring energy charge. EAAs play a major role in neurotoxic cascades. In underperfused tissue, the presynaptic terminals' release of Glu, and the extracellular concentration of this EAA substantially increases. Upon binding with Glu, a conformational change occurs in membrane-bound proteins, allowing the opening of the Glu-activated ion channels. This leads to an influx of Ca_2+ and Na+ into the threatened cell, which initiates an elaborate cascade of events, culminating in DNA damage and thereby triggering an enhanced programmed death of individual cells through "apoptosis".

Pharmacology Fails to Offer Solution

Because ischaemia and reperfusion are overwhelming processes and neurotoxic cascades are complex and involve many steps, pharmacological agents affecting a single portion of these biochemical events will probably have only minimal beneficial effects. So far, an abundant number of neuroprotective agents have been developed and evaluated with promising results in animals, but in humans the results have proven frustrating. Moreover, interventions that are effective for protection and preservation before and during the insult were not typically effective after the ischaemic insult, during the resuscitative stage. Data obtained from "healthy animals" are not necessarily applicable to "sick patients". Interventions that seem effective after brain trauma or focal ischaemia in rats are not consistently effective after CA in monkeys, dogs or humans. Although the different pharmacological strategies have been disappointing, hypothermia appears to offer a promising solution.

Hypothermia Steps in to Fill the Breach

Hypothermia is a state of body temperature, which is below normal in a homeothermic organism. When considering therapeutic hypothermia, we should distinguish between mild (32°–34°C), moderate (28°–32°C), deep (15°–25°C), and profound (<15°C) therapeutic hypothermia.

We should also differentiate between core temperature, such as oesophageal, central venous, pulmonary artery, urinary bladder, rectal temperature, and brain temperature, such as deep brain, cortical, epidural, tympanic membrane, nasopharyngeal, and intra-ventricular temperature.

Finally, we should differentiate between accidental, spontaneous and uncontrolled hypothermia, which is physiologically deleterious because of homoeothermic defences and induced, controlled hypothermia, which under a poikilothermic condition can be therapeutic. Poikilothermia in humans, such as avoidance of shivering, thermogenesis, sympathetic discharge and vasoconstriction, can be caused by the ischaemia- or trauma-induced coma or by sedation or anaesthesia, with or without neuromuscular blockade. Therapeutic hypothermia is different from hibernation, which is poikilothermic down regulation of metabolism and blood flow without tissue hypoxia.

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Therapeutic hypothermia offers the possibility to be induced prior, during and after the insult, though resuscitative hypothermia is less studied than protective and preservative hypothermia. There is, however, growing evidence that resuscitative hypothermia will have some clinical applications. The limiting ability of CPR techniques to resume heart function and the longer interval time needed to reach the scene, might partially explain these disappointing results. Moreover, return of spontaneous circulation, which is important to restore cellular function, may at normothermia provoke deleterious chemical cascades resulting in secondary brain damage.

Either multifaceted treatment strategies or a combination of a single-molecule targeted drug are required to achieve survival without brain damage, because of the multi-factorial pathogenesis of the post-arrest neuronal death. Until recently, there was no therapy available with a documented efficacy in preventing brain damage after CA. Mild hypothermia (33°C) was discovered to mitigate brain damage significantly when induced before, during, or after CA. Therapeutic mild hypothermia (33°C) seems to attenuate the EAA overflow, the overproduction of nitric oxide, and cell apoptosis and thereby mitigates the neurotoxic cascades that occur during the ischaemic insult and during reperfusion.

Studies on Therapeutic Mild Hypothermia

The 2002 European Hypothermia After Cardiac Arrest (HACA) study included only patients who had witnessed CA and initial rhythm of ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT). In this study, the cooling was started at the emergency department and maintained for 24 hours. Survival rates and positive neurological outcomes were significantly higher in the hypothermic group compared to normothermic group (55% vs. 39%).

In a second study, (Bernard et al. 2002), which included 77 patients with the same inclusion criteria as in the HACA study, the cooling was started earlier in the ambulance. The target temperature was 33°C for a period of twelve hours. The authors report a significant improvement of the neurological outcome and survival (49% in the hypothermic group vs. 26% in the normothermic group).

In a later study (Hachimi-Idrissi et al.), only comatose patients after CA of presumed cardiac origin and displaying asystole or pulseless electrical activity (PEA) were included. In this study, a helmet was used as a cooling device for a four-hour period and then the re-warming phase occurred spontaneously over the next eight hours. Favourable neurological recovery occurred in two out of sixteen patients in the hypothermic group and none in the normothermic group.

Advisory Statement Offers Guidance

In June 2003 the International Liaison Committee on Resuscitation formulated an advisory statement for resuscitative mild hypothermia in selected categories of comatose patients resuscitated from CA of cardiac origin. Specifically, it deals with those patients displaying a VF or VT and with no refractory shock or persistent hypoxemia. The extension of resuscitative mild hypothermia to other CA categories of cardiac origin and displaying other rhythms than VF of VT is speculative at the present moment.

Conclusion

Therapeutic mild hypothermia undoubtedly improves the outcome of patients suffering from CA. However, several questions remain unanswered, such the ideal duration of cooling itself, the time frames for inducing hypothermia as well as in the re-warming phase, the level of cooling, and the suitable types of CA. Additional tools in the treatment of this condition with hypothermia would be the design of new techniques or cooling devices that would be both easy and inexpensive to use in the ambulance or pre-hospital setting. ■

continued from p. 10

standards of informed consent and is a source of false high expectations. Advance care planning is frequently uninformed as to what life-sustaining interventions entail, and patient wishes are often unclear. Public education campaigns and development of materials to facilitate the creation of informed advance directives/living wills is needed to fill this gap. Education of substitute decision-makers about their obligations and responsibilities may avoid future stress and anxiety.

Multidisciplinary Approach

A multidisciplinary team approach can provide early and consistent psychological, emotional and spiritual support for the patient and family. Involvement of social workers, spiritual counselors or bioethicists may improve the level of comfort, rapport and trust with the family. The chaplain or religious leader can help address key spiritual and cultural values to ensure patients' wishes are respected. Earlier ethics consultations can help elucidate and build understanding of values, beliefs and goals (Schneiderman, 2006). Conflict, by its very nature is polarising and the involvement of others may help delineate common ground and break impasses.

Resolving Inter- and Intra-Team Conflicts Before Engaging in Decision-Making with the Family

Conflicts among and between healthcare teams need to be discussed in a respectful, open way to

Hypothermia in Acute Ischaemic Stroke

Gene Sung, M.D., M.P.H.
Director
Neurocritical Care and Stroke Division
University of Southern California
Los Angeles, California, US
gsung@usc.edu

The use of hypothermia has been an area of interest for scientists for many decades. Scientific rationale seemed obvious, cold temperatures stopped many of the destructive processes of cell injury and death. Observations of the mammalian diving reflex in humans, with often, full recovery of victims submerged in freezing water for extended periods of time, was certainly one of the many scenarios that have stimulated this research. There has been investigation in all areas of acute neurological injury, including stroke, brain and spine trauma, post-cardiac arrest and even in multiple sclerosis exacerbation.

Two highly studied randomised clinical studies, one from Australia and the other from Europe, involve patients treated after cardiac arrest. The hypothermia protocol in the Australian study (Bernard et al. 2002) began immediate cooling in the ambulance of comatose patients randomly assigned to the hypothermia arm after return of spontaneous circulation from ventricular fibrillation arrest. The temperature goal was 33°C for 18 hours. Of the hypothermia assigned patients, 49% had a good outcome, compared to 26% of those in the normothermia group.

In the European study, there was a similar random selection of arrest patients and early cooling, but with a target temperature of 32° to 34°C, with maintenance for 24 hours. Here again, a statistically significant better outcome was seen, 55% in the hypothermia group versus 39% in the normothermia group.

The largest randomised study to date in traumatic brain injury did not find a significant benefit in outcome or mortality (Clifton et al. 2001). However, the hypothermia group did have lower intracranial pressure readings and there was a benefit seen in the subgroup that was younger than 45 years of age and arrived at hospital already hypothermic.

Unfortunately, the evidence in for hypothermia in the treatment of acute ischaemic stroke is incomplete. There are animal studies that show, in very controlled settings, infarct size is minimised and functional outcome is improved with hypothermia. In a meta-analysis of the literature, 101 publications were reviewed reporting on 3353 animals treated (Van Der Worp et al. 2007). Overall, infarct size was reduced by 44% and neurobehavioral scores were improved by 46%.

Figure 1: Radiant Medical Endovascular Cooling Device, placed in the inferior vena cava and can be used a central line catheter while cooling agent circulates along outside of catheter.

achieve resolution. Few organisations have implemented processes to help resolve disputes among and between healthcare teams. In practice, such conflicts can be significant sources of stress affecting quality of care for patients and families. The development of such processes is urgently needed.

Development of Clear and Detailed Access and Utilisation Policies and Processes

Critical care is a limited resource, particularly in the face of globally limited healthcare resources. Clear and consistent recommendations are needed to guide all healthcare providers on appropriate use of life-sustaining treatments in order to ensure fair and reasonable access to such treatments in times of need. Otherwise, marginal gains to individuals may threaten the welfare of the majority.

Conclusion

Conflicts involving ethical, moral and religious beliefs are sources of anxiety, stress and burnout. Greater attention is needed at a system-wide level to support a culture aimed at preventing and resolving conflicts. Such efforts do not have to be complicated, they do however need to be initiated, revised and enforced, as the necessity of maintaining high quality decision-making is pivotal in improving patient-centred care and attending to the needs of all patients who may benefit from critical care services in the future. ■

Studies in humans have been limited to small studies, often non-randomised. Examples are the COOL-AID (Cooling for Acute Ischaemic Brain Damage) studies. In the first, 10 patients were treated with an external cooling blanket to reach a goal temperature of 32°C and in the second, forty patients were treated within 12 hours of symptom onset using an endovascular cooling device (Fig.1) for a goal temperature of 33°C (Krieger et al. 2001). The range of times after symptom onset that hypothermia was initiated averaged 6 hours and the duration ranged from 23.5 to 96 hours in the first study. In the latter study, the range of times averaged 9 hours and the duration goal was 24 hours (De Georgia et al. 2004). These studies showed that it was feasible and safe to cool acute ischaemic stroke patients, though they were too small to demonstrate any definitive benefit.

The Intravascular Cooling in the Treatment of Stroke-Longer tPA Window (ICTuS-L) study is currently under way and is testing the combination of intravenous tissue plasminogen activator (tPA) and hypothermia. ICTuS-L is a phase I safety study and is building on the initial ICT-uS study (Lyden et al. 2005) which examined the feasibility and safety of an endovascular cooling device in awake acute ischaemic stroke patients.

In another study done in Copenhagen, 17 patients were treated using a cool air blanket and body temperature decreased on average from 36.8°C to 35.5°C (Kammersgaard et al. 2000). This led to a multi-centre randomised trial called the Nordic Cooling Stroke Study, which was unfortunately terminated because of slow recruitment. A multi-centre study that the author has organised, (CHILI-Controlled Hypothermia in Large Infarction) has a temperature goal of 35°C for 48 hours in subjects with large hemispheric strokes prior to significant mass effect and controlled re-warming over 72 hours using a super-conductive gel pad cooling device (Fig. 2).

Figure 2: Medivance Arctic Sun system using cooled water to circulate through super-conductive gel pads.

While the majority of investigators believe that hypothermia, as a concept should work in the treatment of acute ischaemic stroke, proving it has been difficult. None of the parameters integral to hypothermia have been definitively determined: The timing after stroke onset, the speed of induction, the best temperature, the duration of hypothermia, nor the delivery of hypothermia.

Certainly, hypothermia can lead to medical complications. The potential complications are almost unlimited, with the effects of hypothermia stopping harmful cellular injury processes, but also blunting useful processes such as the immune response. Complications noted included pneumonia, sepsis, hypotension, bradycardia, arrhythmias and coagulopathies. Another direct response to hypothermia is shivering, which is the body's attempt to combat the abnormally cool temperature and must be controlled.

Figure 3: BeneChill cooling system with inert gaseous cooling agent introduced through intranasal catheter.

A novel device that is being examined in an attempt to limit cooling to the brain and perhaps avoid some of the complications of systemic hypothermia is the BeneChill device (Fig. 3). This device uses the nasal cavity for heat transfer, taking advantage of its highly vascularised environment and its proximity to the brain. An inert cooling agent is delivered directly to the nasal cavity and circulates in gaseous form. A study is underway examining its cooling capabilities to the brain.

Hypothermia in acute ischaemic stroke is an extremely promising treatment undergoing continued investigation to find the best therapeutic parameters and delivery methods for the best results. ■

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Basic Defibrillators

ECRI Europe

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ECRI is pleased to provide readers of **ICU Management** with sample information on Basic Defibrillators, designed for use in critical care from its Healthcare Product Comparison System (HPCS), which contains over 280 reports. The HPCS reports contain extensive information about the technology, its purpose, its principles of operation, stage of development specifications and reported problems. The Basic Defibrillators for critical care comparison charts include ECRI's 'Recommended Specifications' (generic templates) which can be used for comparison and tendering purposes. The comparative tables overleaf are extracted from ECRI's 2005 database and have additionally been reviewed and updated by the respective manufacturers.

Publication of all submitted data is not possible. For further information please contact editorial@icu-management.org or visit www.icu-management.org.

ECRI Europe
Weltech Centre, Ridgeway Welwyn Garden City,
Herts AL7 2AA, United Kingdom
Tel. +44 (0)1707 871511
Fax. +44 (0)1707 393138
info@ecri.org.uk www.ecri.org.uk

Healthcare Product Comparison System

	ECRI RECOMMENDED SPECIFICATIONS[1]	ZOLL
MODEL	**BASIC DEFIBRILLATORS**	**R Series - Code Ready Professional Manual defibrillator**
WHERE MARKETED		Worldwide
FDA CLEARANCE		Yes
CE MARK (MDD)		Yes
DEFIBRILLATOR		
Energy selection, J		
Internal	5-50	1-10, 15, 20, 30, 50
External	50-360 monophasic, 50-200 biphasic, 2-20 pediatric/neonatal	1-10, 15, 20, 30, 50, 75, 100, 120, 150, 200
Paddle controls	Charge, discharge, energy select	Energy select, charge, discharge, recorder on/off
Waveform shape	Biphasic preferred	Rectilinear biphasic
Biphasic, energy, J	50-200	1-10, 15, 20, 30, 50, 75, 100, 120, 150, 200
Synchronizer	Yes	Yes
Pediatric paddles	Yes	Integral
Optional paddles	Any (based on user requirements)	Adult/pediatric, internal, anterior/posterior
Disposable electrodes	Adult and pediatric	Yes, OneStep resuscitation electrode familly
ECG MONITOR		
Type	No preference	Integral, Color, VGA, Liquid crystal display (LCD)
Screen, cm (in)	No preference	16.5 (6.5) diagonal
Sweep speed, mm/sec	25	25
Trace freeze	Optional	No
Lead configuration	I, II, III (3 lead)	I, II, III (3-lead); I, II, III, aVR, aVL, aVF (5-lead); P1, P2, P3 with one step pacing electrode
Through-the-paddles monitoring	Yes	Yes
HR display	Yes	Yes
HR alarms	Yes	Selectable 20-280
Freq response, Hz	0.67-40	0.05-150
Lead-fault indicator	Yes	Audible alert and on display
EXTERNAL PACEMAKER	Optional	Optional
Pacing mode	Demand, fixed rate	Demand or fixed rate
Pacing rate, ppm	50-150	30-180
Output current, mA	0-140	0-140
Pulse width, msec	>20	40, rectilinear
ECG RECORDER	Yes	Thermal array (80 mm width)
Paper speed, mm/sec	25	25
Auto/manual print	Auto, manual	Auto, manual
Annotation	Time, date, lead, gain, heart rate, operating mode	Time, date, energy, heart rate, pacer output (pacer version only), QRS sync mark, ECG-size lead, alarm, defib test (OK/fail), analyse ECG, ECG Bandwidth, more
Summary feature	Yes	Yes
UNIT		
H x W x D, cm (in)		20.8 x 26.7 x 31.7 (8.2 x 10.5 x 12.5)
Weight, kg (lb)	<9.1 (20)	5.8 (13.0) with battery pack and OneStep Cable
External outputs	1 V ECG out	1 V ECG out
WARRANTY		1 year
OTHER SPECIFICATIONS		The first Code ready defibrillator. Features a large color screen, an optional Advisory function, and the intuitive ZOLL user interface. Performs automatic selftest of the complete system. Allows rapid deployment and administration of therapy through a unique OneStep Cable and OneStep electrode system for Monitoring, Defibrillation,[2]

Footnotes used in pages 25 to 28

1. These recommendations are the opinions of ECRI's technology experts. ECRI assumes no liability for decisions made based on this data.
2. Cardiovertion and Pacing. Features unique Real CPR Help for real-time feedback on CPR performance. Allows minimizing interuptions to CPR with SeeThru-CPR and CPR idle time display. Other options include amongst others: SpO_2, 5-lead patient cable, external paddles.

Healthcare Product Comparison System

	ECRI RECOMMENDED SPECIFICATIONS[1]	ZOLL	ZOLL	WELCH ALLYN	
MODEL	**BASIC DEFIBRILLATORS**	**M Series - Professional Manual defibrillator**	**M Series CCT - Critical Care Transport defibrillator**	**PIC 30**	
WHERE MARKETED		Worldwide	Worldwide	Worldwide	
FDA CLEARANCE		Yes	Yes	Yes	
CE MARK (MDD)		Yes	Yes	Yes	
DEFIBRILLATOR					
Energy selection, J					
Internal	5-50	1-10, 15, 20, 30, 50	1-10, 15, 20, 30, 50	2-10, 15, 20, 30, 50	
External	50-360 monophasic, 50-200 biphasic, 2-20 pediatric/neonatal	1-10, 15, 20, 30, 50, 75, 100, 120, 150, 200	1-10, 15, 20, 30, 50, 75, 100, 120, 150, 200	2, 5, 7, 10, 20, 30, 50, 70, 100, 150, 200, 300, 360	
Paddle controls	Charge, discharge, energy select	Energy select, charge, discharge, recorder on/off	Energy select, charge, discharge, recorder on/off	Charge, discharge, energy select	
Waveform shape	Biphasic preferred	Rectilinear biphasic	Rectilinear biphasic	Truncated exponential biphasic	
Biphasic, energy, J	50-200	1-10, 15, 20, 30, 50, 75, 100, 120, 150, 200	1-10, 15, 20, 30, 50, 75, 100, 120, 150, 200	User selectable	
Synchronizer	Yes	Yes	Yes	Yes, delivers energy within 60 msec	
Pediatric paddles	Yes	Integral	Integral	Yes	
Optional paddles	Any (based on user requirements)	Adult/pediatric, internal, anterior/posterior	Adult/pediatric, internal, anterior/posterior	Adult, internal, pediatric, remote hands-free	
Disposable electrodes	Adult and pediatric	Multifunction, sterile, radiolucent 2, pediatric	Multifunction, sterile, radiolucent 2, pediatric	Yes	
ECG MONITOR					
Type	No preference	Integral, High-res EL	Integral, High-res color TFT	Integral LCD color	
Screen, cm (in)	No preference	14.4 (5.7) diagonal	16.5 (6.5) diagonal	16.5 (6.5) diagonal	
Sweep speed, mm/sec	25	25	25	25	
Trace freeze	Optional	No	No	Yes	
Lead configuration	I, II, III (3 lead)	I, II, III (3-lead); I, II, III, aVR, aVL, aVF, (5-lead)	I, II, III (3-lead); I, II, III, aVR, aVL, aVF, (5-lead)	Paddles (pads), I, II, III, aVR, aVL, aVF, V	
Through-the-paddles monitoring	Yes	Yes	Yes	Yes	
HR display	Yes	Yes	Yes	Yes	
HR alarms	Yes	Selectable 20-280	Selectable 20-280	User selectable or automatic	
Freq response, Hz	0.67-40	0.05-150	0.05-150	0.05-150, 0.5-40, 2-20; user selectable	
Lead-fault indicator	Yes	Audible alert and on display	Audible alert and on display	Yes	
EXTERNAL PACEMAKER	Optional	Optional	Optional	Yes	
Pacing mode	Demand, fixed rate	Demand or fixed rate	Demand or fixed rate	Demand or asynchronous	
Pacing rate, ppm	50-150	30-180	30-180	30-180	
Output current, mA	0-140	0-140	0-140	30-180	
Pulse width, msec	>20	40, rectilinear	40, rectilinear	20	
ECG RECORDER	Yes	Thermal array (80 mm width)	Thermal array (80 mm width)	Thermal	
Paper speed, mm/sec	25	25	25	25	
Auto/manual print	Auto, manual	Auto, manual	Auto, manual	Both	
Annotation	Time, date, lead, gain, heart rate, operating mode	Time, date, energy, heart rate, pacer output (pacer version only), QRS sync mark, ECG-size lead, alarm, defib test (OK/fail), pads off, more	Time, date, energy, heart rate, pacer output (pacer version only), QRS sync mark, ECG-size lead, alarm, defib test (OK/fail), pads off, noisy ECG, advisory prompts, more	Time, date, ECG lead, ECG gain, heart rate, defibrillation and pacing parameters, event type	
Summary feature	Yes	Yes	Yes	Yes	
UNIT					
H x W x D, cm (in)		17 x 25.8 x 20.5 (6.8 x 10.3 x 8.2)	26 x 26 x 22 (10.2 x 10.2 x 8.7)	42.2 x 31.8 x 13.5 (16.6 x 12.5 x 5.3)	
Weight, kg (lb)	<9.1 (20)	5.2 (11.5); 6.1 (13.5) with paddles	7.8 (17.2)	6 (13.2)	
External outputs	1 V ECG out	1 V ECG out	1 V ECG out	Not specified	
WARRANTY		1 year	1 year	3 years	
OTHER SPECIFICATIONS		Full-featured professional external defibrillator with the intuitive ZOLL user interface; available in a manual configuration, in a manual configuration with advisory function, or as an AED with manual override mode. Available options include: NIBP, SpO_2, $ETCO_2$ (Sidestream and/or mainstream), 5-lead patient cable, external paddles, internal spoons, 12-lead ECG, carrying case.	Critical care transport defibrillator for transport of critically ill patients. Features a large color screen, an Advisory function, and the intuitive ZOLL user interface. Options include: IBP, Temperature, NIBP, SpO_2, $ETCO_2$ (Sidestream and/or mainstream), 5-lead patient cable, external paddles, internal spoons, 12-lead ECG, carrying case.	Welch Allyn biphasic technology; optional advisory defibrillation, external pacing, and hands-free defibrillation.	

ECRI RECOMMENDED SPECIFICATIONS[1]	WELCH ALLYN	MEDTRONIC	MEDTRONIC	PHILIPS MEDICAL SYSTEMS
BASIC DEFIBRILLATORS	**PIC 40 : PIC 50**	**LIFEPAK 12**	**LIFEPAK 20**	**Heartstart MRx M3535A : M3536A**
	Worldwide	Worldwide	Worldwide	Worldwide
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
5-50 50-360 monophasic, 50-200 biphasic, 2-20 pediatric/neonatal	2-10, 15, 20, 30, 50 2, 5, 7, 10, 20, 30, 50, 70, 100, 150, 200, 300, 360	5, 10, 20, 30, 50 2-10, 20, 30, 50, 70, 100, 150, 200, 300, 360; 2 user-configurable sequences	5, 10, 20, 30, 50 2-10, 15, 20, 30, 50, 70, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 360; 2 user-configurable sequences	1-10, 15, 20, 30, and 50 1-10, 15, 20, 30, 50, 70, 100, 120, 150, 170
Charge, discharge, energy select	Charge, discharge, energy select	Charge, discharge, print	Charge, discharge	Charge, discharge, impedance indication
Biphasic preferred	Truncated exponetial biphasic	Biphasic	Biphasic	Biphasic truncated exponential
50-200	User selectable	2-10, 15, 20, 30, 50, 70, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 360; 3 user-configurable sequences (100-200, 100-300, and 100-360)	2-10, 15, 20, 30, 50, 70, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 360; 3 user-configurable sequences (100-200, 100-300, and 100-360)	1-10, 15, 20, 30, 50, 70, 100, 120, 150, 170
Yes	Yes, delivers energy within 60 msec	Yes	Yes	Yes
Yes	Yes	Optional	Built-in	Yes
Any (based on user requirements)	Adult, internal, pediatric, remote hands-free	Pediatrics, posterior, internal, external sterilizable	A/P, internal, external sterilizable	Reusable/sterilizable internal switched and switchless and sterile/disposable internal switched and switchless
Adult and pediatric	Yes	Quik-Combo, Edge Quik-Combo for pacing/defibrillation/ECG, Edge Quik-Pace, Edge Pediatric Quik-Combo, REDI-PAK Quik-Combo (Edge REDI-PAK Quik Combo)	Quik-Combo, Edge Quik-Combo for pacing/defibrillation/ECG, Edge Quik-Pace, Edge Pediatric Quik-Combo, REDI-PAK Quik- Combo (Edge REDI-PAK Quik-Combo)	Adult/pediatric multifunction, radiotransparent and radiolucent
No preference	Integral LCD color	LCD or EL	Color LCD	Integral
No preference	16.5 (6.5) diagonal	14.1 x 10.6 (5.5 x 4.2) LCD, 16.5 x 12.4 (6.5 x 4.9) EL	11.5 x 8.6 (4.5 x 3.4)	12.8 x 17.1 (5.1 x 6.8)
25	25	25	25	25
Optional	Yes	No	No	No
I, II, III (3 lead)	Paddles (pads), I, II, III, aVR, aVL, aVF, V	I, II, III, paddles, aVL, aVR, aVF, V1-V6, optional 12 lead	I, II, III, paddles, aVL, aVR, aVF	I, II, III, aVR, aVL, aVF, V
Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes
Yes	User selectable or automatic	Adjustable, configurable	Adjustable, configurable	Preset, adjustable
0.67-40	0.05-150, 0.5-40, 2-20; user selectable	0.5-40 monitor, 2.5-30 paddles, 0.05-150 diagnostic	0.05-150 or 0.05-40 diagnostic, user configurable; 0.67-40 or 1.0-30 monitor, user configurable; 2.5-30 paddles; 0.67-32 analog ECG out, except 2.5-30 for paddles	0.15-40
Yes	Yes	Yes	Yes	Yes
Optional	Yes	Optional	Optional	Yes
Demand, fixed rate	Demand or asynchronous	Demand or nondemand	Demand or nondemand	Demand or fixed
50-150	30-180	40-170	40-170	30-180
0-140	30-180	0-200	0-200	10-175
>20	20	20	20	40
Yes	Thermal	Thermal array, 50 or 100 mm	Thermal array, 50 mm	Thermal array
25	25	25	25	25
Auto, manual	Both	Both	Both	Both
Time, date, lead, gain, heart rate, operating mode	Time, date, ECG lead, ECG gain, heart rate, defibrillation and pacing parameters, treatment summary, ACLS events	Time, ECG lead, ECG gain, HR, therapy parameters, synchronization, discharges, SpO_2, presenting rhythms, 12 lead, AED analysis, pacing parameters, $ETCO_2$ and NIBP parameters	Time, ECG lead, ECG gain, HR, synchronization, discharges, SpO_2, pacing parameters, presenting rhythms, therapy parameters, AED analysis	Date, time, alarms, patient type, HR, NIBP, SpO_2; pulse, $ETCO_2$, AwRR, mode, synchronization, pacer mode, lead, marked events, drug annotations, shock delivery, disarm, battery status
Yes	7 switches to record ACLS events, auto log, time/ECG sample	Enhanced code summary, critical-event record	Enhanced code summary, critical-event record	Yes
	33 x 31.8 x 13.5 (13 x 12.5 x 5.3)	31.7 x 38.9 x 21.7 (12.5 x 15.3 x 8.5)	21.3 x 26.2 x 26.2 (8.4 x 10.3 x 10.3)	31.5 x 21 x 29.5 (12.4 x 8.3 x 11.6)
<9.1 (20)	4.5 (10)	6 (13.3)	5.8 (12.3) fully featured	6 (13.2)
1 V ECG out	1 V RS232, fax	ECG, data transfer via modem/serial	IrDA port and direct serial port	1 V ECG
	3 years	5 years, hospital; 1 year, out of hospital	5 years, hospital	5 years, repair and return
	Upgradable to SpO_2, NIBP, external pacing, AED (with voice and text prompts), data record and playback : SpO_2; respiration; optional 12-lead ECG, 12-lead ECG interpretation, external pacing, NIBP, temperature, CO_2, 2 IBP, AED, data card, and communication.	AED and manual defibrillation; data storage; NIBP/Masimo SET SpO_2/$ETCO_2$; Muse CV and LifeNet compatible; battery system using Smart battery technology; configurable; upgradable; fax; voice recording; 2 IBP inputs; 100 mm printer; Bluetooth wireless transmission; optional SpO_2 and diagnostic interpretive 12-lead ECG.	AED mode quickly converts to manual mode when door is opened; user-configurable screen options; biphasic technology adjusts both shock duration and voltage; provides escalating energy levels as required; color-coordinated parameters on display; Masimo SET; docking station.	Pacing, SpO_2, NIBP, $ETCO_2$, airway respiration rate, 12-lead transmission, and 75 mm printer upgradable; optional 5-lead ECG cable and 12-lead cable.

	ECRI RECOMMENDED SPECIFICATIONS[1]	PHILIPS Medical SYSTEMS	SCHILLER	SCHILLER
MODEL	**BASIC DEFIBRILLATORS**	**Heartstrat XL M4735A**	**DG 4000**	**DG 5000**
WHERE MARKETED		Worldwide	Worldwide, except North America	Worldwide, expect North America
FDA CLEARANCE		Yes	Not yet submitted	Not yet submitted
CE MARK (MDD)		Yes	Yes	Yes
DEFIBRILLATOR				
Energy selection, J			Not specified	Not specified
Internal	5-50	2, 3, 5, 7, 10, 20, 30, and 50	No	2, 4, 6, 8, 15, 30
External	50-360 monophasic, 50-200 biphasic, 2-20 pediatric/neonatal	2, 3, 5, 7, 10, 20, 30, 50, 70, 100, 150, 200	2, 4, 8, 15, 30, 50, 70, 90, 120, 150, 200	Paddles: 2, 4, 6, 8, 15, 30, 50, 90, 130, 180 - Pads: 2, 4, 6, 8, 15, 30, 50, 70, 90, 110, 130, 150, 180
Paddle controls	Charge, discharge, energy select	Charge, discharge, impedance indication	Controls are all on the front pannel	Charge, energy selection, start printer, discharge
Waveform shape	Biphasic preferred	Biphasic truncated exponential	Biphasic multipulse biowave	Biphasic multipulse biowave
Biphasic, energy, J	50-200	2, 3, 5, 7, 10, 20, 30, 50, 70, 100, 150, 200	Energies in AED mode are configurable	Energies in AED mode are configurable
Synchronizer	Yes	Yes	Yes	Yes
Pediatric paddles	Yes	Yes	Yes	Yes
Optional paddles	Any (based on user requirements)	Reusable/sterilizable internal switched and switchless and sterile/disposable internal switched and switchless		Internal, adhesive pads, pediatric
Disposable electrodes	Adult and pediatric	Adult/pediatric multifunction, radiotransparent and radiolucent	Adhesive electrodes adult and paediatric	Adhesive electrodes adult and paediatric
ECG MONITOR				
Type	No preference	Integral	Monochrome LCD	Color LCD
Screen, cm (in)	No preference	11.5 x 8.6 (4.5 x 3.4)	13 x 7 (5.1 x 2.7)	21.1 x 15.8 (8.3 x 6.2)
Sweep speed, mm/sec	25	29	25	25-50
Trace freeze	Optional	No	No	No
Lead configuration	I, II, III (3 lead)	I, II, III, aVR, aVL, aVF, V	I, II, III, aVR, aVL, aVF	I, II, III, aVR, aVL, aVF, V1-V6
Through-the-paddles monitoring	Yes	Yes	Yes	Yes
HR display	Yes	Yes	Yes	Yes
HR alarms	Yes	Present, adjustable	Yes	Yes
Freq response, Hz	0.67-40	0.15-40	1-35 or 0.05-150 (according to ECG source)	1-35 or 0.05-150 (according to ECG source)
Lead-fault indicator	Yes	Yes	Audible and visual	Audible and visual
EXTERNAL PACEMAKER	Optional	Yes	Optional	Optional
Pacing mode	Demand, fixed rate	Demand or fixed	Fixed, demand	Fixed, demand, overdrive
Pacing rate, ppm	50-150	30-180	40-210	40-210
Output current, mA	0-140	10-200	0-150	0-150
Pulse width, msec	>20	20	40	40 (20ms in overdrive mode)
ECG RECORDER	Yes	Thermal array	Thermal array 72 mm	Thermal array 72 mm, 3 traces
Paper speed, mm/sec	25	25	25	25, 50
Auto/manual print	Auto, manual	Both	Both, selectable	Both, selectable
Annotation	Time, date, lead, gain, heart rate, operating mode	Date, time, HR, SpO2, current mode, lead, gain, filter setting, synchronization, pacer settings, drug, charge to, shock delivered, no shock delivered, disarm, battery low	1 or 2 waveforms, all events and data measurements	3 waveforms, all events and data measurements
Summary feature	Yes	Yes	24 hr trends on all parameters	24 hr trends on all parameters
UNIT				
H x W x D, cm (in)		19 x 37.6 x 34.7 (7.5 x 14.8 x 13.6)	27 x 31 x 16 (10.6 x 12.2 x 6.3)	28.9 x 17.7 x 27.1 (11.4 x 7 x 10.7)
Weight, kg (lb)	<9.1 (20)	6 (13.2)	5.3 (11.7) with all options battery and paddles	5.6 (12.3) with 2 batteries and paddles
	1 V ECG out	1 V ECG		
External outputs			RS232, USB	RS232, USB, Ethernet
WARRANTY		1- or 5-year unit exchange	1 year	1 year
OTHER SPECIFICATIONS		Pacing and SpO2 upgradable; optional 5-lead ECG cable.	Data transmission Option (internal modem)	Data transmission Option (USB Modem or Ethernet)

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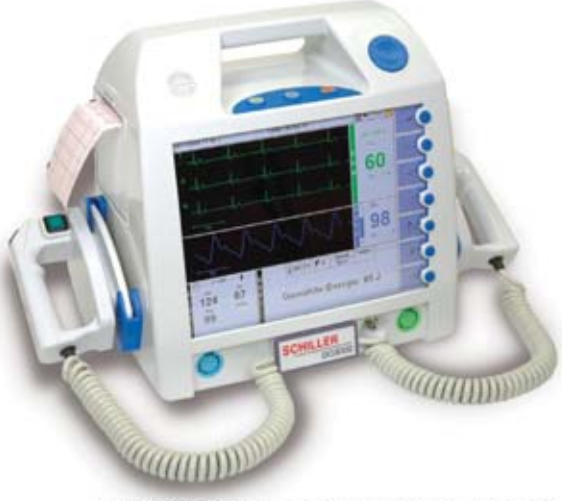

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Failed Intubation in a Paralysed Patient

Dr. Thomas Heidegger
(above)
Consultant Anaesthetist
Quality Manager in Healthcare
Department of Anaesthesia
Walenstadt, Switzerland
thomas.heidegger@srrws.ch

Dr. Hans Joerg Gerig
Consultant Anaesthetist
Department of Anaesthesiology
Cantonal Hospital St. Gallen
St. Gallen, Switzerland

Research has amply demonstrated that the two most important tasks for the anaesthetist are management of the difficult airway and maintenance of oxygenation. Respiratory problems are still the most important single cause of anaesthetic adverse events leading to a bad outcome. The true number of these cases is likely to be significantly greater than those published. The question of what to do after failed intubation in the paralysed patient is a daily business. Thus, one could be forgiven for presuming that guidelines for its management are fairly standardised. Unfortunately, this is not the case. This article sets out some useful guidelines for practitioners to ensure best practice.

Should one be at a loss as to what procedure to follow after failed intubation in the paralysed patient, the first fundamental question is whether you can oxygenate the patient. If the answer is yes, you can consider your preferred technique on how to manage this particular problem. Deciding which supraglottic airway device is used should be based on the following parameters:

1. Clinical evidence;
2. Incidence of major and minor laryngeal morbidities;
3. Limitation in this special situation; and,
4. Availability, experience and hence preference of the user.

The key point is that only a sufficient range of proven techniques should be practiced every day to facilitate successful use in emergencies.

continued on p. 35

Institution/Country	Algorithm
American Society of Anaesthesiologists	Three intubation attempts, spontaneous ventilation, face mask, alternative approaches (laryngeal mask), awaken patient
Canada	Optimise laryngoscopy, alternatives (light stylet, fiberoptics), awaken patient
France	Two intubation attempts, laryngeal mask, fibreoptics/special blades (two further attempts), awaken patient
UK (Difficult Airway Society)	Four intubation attempts, intubating laryngeal mask or laryngeal mask, revert to face mask ventilation, awaken patient
Italy (SIAARTI)	Help, two intubation attempts, (awaken patient), alternative devices, two further attempts, laryngeal mask/extraglottic device
Germany	Intubation with alternative attempts, laryngeal mask or intubating laryngeal mask, spontaneous ventilation, fiberoptics, awaken patient

Table 1: Different guidelines – Paralysed patient where oxygenation is possible

Institution/Country	Algorithm
American Society of Anaesthesiologists	Laryngeal mask, help, transtracheal catheterisation, surgical cricothyroidotomy
Canada	One intubation attempt, laryngeal mask, Combitube®, awakening, transtracheal airway
France	Laryngeal mask, transtracheal catheterisation, surgical cricothyroidotomy
UK (Difficult Airway Society)	Help, laryngeal mask, transtracheal catheterisation, surgical cricothyroidotomy
Italy (SIAARTI)	Oxygenation; laryngeal mask / extraglottic device; transtracheal catheterisation or surgical cricothyroidotomy
Germany	Oxygenation; laryngeal mask or Combitube®; transtracheal catheterisation or surgical cricothyroidotomy

Table 2: Managing a difficult mask ventilation where oxygenation is impossible

Quality Improvement In Intensive Care Units

ICU Physicians Ideally Positioned to Lead the Way

L. Chelluri, MD, MPH
Professor of Critical Care Medicine
Department of Critical Care Medicine
University of Pittsburgh School of Medicine
Pittsburgh PA, US
chelluril@ccm.upmc.edu

Improvements in life-sustaining technologies in the past few decades have resulted in an increase in the number of intensive care units. Critical care is resource intensive, with 25 - 30% of the overall hospital budget allocated for the care of critically ill patients. However, increased financial and human costs, due to a lack of monitoring of processes, can have a detrimental outcome on the service. Improvement in quality of care in the ICUs at a tertiary care centre resulted in an estimated saving of $2.6 million per year (Clemmer et al.1999). So how is quality improvement destined to improve ICU economics?

Physicians can be skeptical of quality improvement efforts and view them as a non-productive use of their time as well as interfering with their autonomy. However, it is well known that significant variation in the process of care delivery, based on physician training, preferences, and availability of resources causes inefficiencies that can be improved by QI initiatives. These studies provide clear evidence that monitoring and eliminating unexplained variations results in improved performance.

Negative physician opinions can be effectively countered by positive actions such as suggestions from a respected professional colleague/role model, appropriate provision to support development of necessary skills, reinforcement by colleagues, feedback from patients and visible results. Due to the multi-disciplinary nature of their work, intensive care physicians are well positioned to become leaders in quality improvement initiatives.

Measures for Success

The success of QI projects depends on the following measures:

- Identify projects all stakeholders agree on in terms of usefulness;
- clearly define measures and outcomes;
- incorporate data collection into daily work;
- build a team culture;
- ensure measures/projects are valid, reliable, and important to all stakeholders;
- provide leadership and a detailed plan on design/implementation;
- provide costs and a timeline to help obtain leadership buy-in;
- develop the team in necessary areas;
- define processes and outcomes, and follow with an iterative process of implementation, evaluation/analysis; and change the process based on the evaluation (Brock et al. 1998).

The structure of QI projects in the ICU setting depends on the type and size of ICU, nature of staffing (closed vs. open), and availability of technology. Relevant issues for analysis include:

- Communication between staff;
- use of available technology and guidelines; and
- supervision of trainees.

Outcomes include:

- Resource use as indicated by length of stay;
- procedures; and
- mortality.

continued on p. 33

QI Measure	Process measures	Outcome measures
Ventilator Associated Pneumonia (VAP)	Head of the bed elevation, mouth care, early and appropriate diagnostic measures and antibiotic therapy	Compliance with individual processes, incidence of ventilator associated pneumonia
Central Line Associated Bacteremia (CLAB)	Hand hygiene, barrier precautions (gown, mask, hat gloves, wide barrier) daily evaluation for the need of the catheter and early removal	Compliance with individual processes and incidence of CLAB (number of infections/1000 days)
Sepsis	Early Goal Directed Therapy (EGDT), cultures, early antibiotic therapy, low dose steroids, activated protein C	Compliance with individual measures, 28-day mortality
Sedation	Daily interruption of sedative infusions, titration of sedation to sedation/agitation goals	Compliance with individual measures, length of stay in ICU, duration of mechanical ventilation
Liberation from Mechanical Ventilation (MV)	Daily Spontaneous Breathing Trials (SBT)	Compliance with SBT, duration of MV, number of reintubations
Blood Transfusions	Use of specific transfusion trigger (e.g. Haemoglobin >7.5) and transfusion of one unit of RBC at a time, in the absence of active bleeding or cardiac ischaemia	Compliance with trigger, number of RBC transfusions

Table 1: Examples of QI measures

Extended Duration Workshifts

The Impact on House Staff and Patient Safety

'On call' or extended duration shifts, i.e., shifts greater than 24 hours in length, are commonly worked by house staff in critical care settings, resulting in both acute and chronic sleep deprivation. It has been well demonstrated that this degree of fatigue impairs cognitive function on standardised tasks. Furthermore, recent studies, including those specifically focussed on critical care units, have shown that house staff fatigue negatively impacts both patient and occupational safety outcomes.

Scot A. Mountain
(picture above)
scotmountain@gmail.com

Bradley S. Quon
The Department of Medicine
University of British Columbia
Vancouver, British Columbia
Canada

Najib T. Ayas
(picture below)
Sleep Disorders Program and Respiratory and Critical Care Divisions
University of British Columbia
Vancouver, British Columbia
Canada
najib.ayas@vch.ca

General Effects of Sleep Deprivation

Loss of sleep can either be "acute-continuous", such as is experienced after a single extended shift, or "chronic-partial", as occurs with a busy schedule that repeatedly causes an individual to sleep less than they would if given sufficient opportunity. Interestingly, either type of sleep loss can have significant impacts on performance. Studies comparing the effect of 24 hours of wakefulness to that of elevated blood alcohol levels found that standardised tasks in sleep-deprived subjects were impaired as if they had blood alcohol levels of 0.05 to 0.10% (above the legal driving limit in all US states).

Recurrent sleep loss on a daily basis can have a similar effect. This type of sleep reduction tends to have a cumulative impact, with dose-dependant reduction in cognitive performance. For example, chronic restriction of sleep to six hours or less per night for two weeks produces cognitive performance deficits similar to one night of total sleep deprivation. Restriction to four hours per night for two weeks produces performance deficits equivalent to two nights of total sleep deprivation. For ICU staff other than interns and residents, this type of sleep deprivation is probably the most common.

Impact of Sleep Deprivation on Occupational Safety

The threats to patients and occupational safety of sleep-deprived ICU house staff are often overlooked. However, it is important for ICU managers to be aware of the risks, both out of concern for their fellow workers, and in consideration of the staffing and legal liability implications.

The increased risk of a motor vehicle collision (MVC), or near miss incident, has been demonstrated in large cohort studies of interns and residents working extended shifts. The threat has been quantified as up to a four-fold increase of an MVC, and a six-fold increase of a near-miss incident. With multiple extended shifts in a month, the risk of falling asleep while driving is increased by almost four times.

Interns working extended shifts have also been found to have a significantly increased risk of percutaneous injuries (needle sticks or lacerations). After working overnight in the ICU, residents have been shown to have a risk of such injuries that is nearly double that of their rested colleagues.

Other less easily quantified health risks exist as a result of recurrent work related fatigue. Many authors have demonstrated an increased rate of mental health concerns in fatigued interns and residents, including increased rates of stress, depression, and burnout. In the ICU, serum levels of inflammatory markers have been shown to be elevated in house staff working extended shifts.

Impact of Sleep Deprivation on Patient Safety

Until recently, studies examining patient outcomes as a function of house staff fatigue have been rare, and sometimes contradictory. It has been suggested that the variability in results may be a function of sleep deprivation impacting different tasks to different degrees (Barger et al. 2006). In the past several years, in an effort to determine the ICU-specific risks, several studies have examined the effect of alternative house staff schedules on fatigue and patient outcomes.

In a crossover trial of house staff working in critical care units at the Brigham and Women's Hospital in Boston, Massachusetts, interns worked both a traditional schedule and a schedule that eliminated extended work hours and replaced them with shifts no longer than sixteen hours. During the traditional schedule, in which they were on-call overnight every third night, interns made 36% more serious medical errors, and diagnostic errors increased almost six fold (Landrigan et al. 2004). Alternative shift schedules have been criticised for the possibility that the requirement for increased handover may lead to losses of relevant information, and worsened patient outcomes. However, investigators examining this premise have not shown any difference in patient mortality or ICU length of stay associated with shorter shift schedules (Afessa et al. 2005).

Optimising Shift Length

Optimal shift length and frequency has not been systematically determined for any members of the ICU team. The cumulative negative effects of fatigue suggest that it is important to be aware of potential performance impacts for all ICU workers, not just house staff. Certainly it seems advisable to limit or eliminate the number of times in a month that extended shifts (>24 hours in length) are worked, whether they are a result of traditional scheduling practices or excessive overtime.

With respect to interns and residents, this data regarding various scheduling strategies allows us to make some inferences as to optimal shift length. We have already reviewed the evidence suggesting that shift lengths of no more than sixteen hours significantly reduce the incidence of serious medical errors. In Europe, thanks to the introduction of the European Working Time Directive, it has been possible to examine the other end of the spectrum.

Investigators in Germany have shown that eight-hour physician shifts were inferior to twelve-hour shifts with respect to multiple ICU outcomes, including length of stay, readmission, and frequency of complications (Bollschweiler et al. 2001). These results suggest that shorter shifts may carry their own risks, possibly validating concerns about adverse events related to handovers and discontinuity of care. Nevertheless, optimal shift lengths for ICU house staff are likely between twelve and sixteen hours. For other ICU workers, such as nurses, who may require longer periods of uninterrupted focus, shorter shift lengths may be preferred, although presumably increased handover between nurses also contributes to patient risk.

Conclusion

Sleep deprivation caused by extended duration shifts contributes to significant risks for both staff and patients. Reduction of these risks is possible by optimising shift lengths, and being aware of the effect of cumulative fatigue due to chronic shortened sleep hours. Currently, especially in North America, few ICUs have adopted alternative schedules despite mounting evidence suggesting a significant reduction in medical errors, and improvement in employee health and safety. Consideration for the well-being of our fellow workers and the safety of our patients should provide sufficient motivation to consider breaking with tradition and implementing more appropriate scheduling practices. ■

continued from p. 31

Although outcome measures, such as length of stay and mortality, are easier to measure, they are influenced by multiple variables and it is difficult to attribute the outcomes to a single intervention. Interventions affecting the structure take longer to implement and are more expensive. So, initially it is easier to target processes of care, modifying them as needed, and measuring the outcomes affected by the process.

Quality Improvement Projects in the ICU

As patients in the ICU are heterogeneous in terms of acuity of the disease, co-morbidities and age, any evaluation of quality needs to consider these varied factors. Use of risk adjustment models such as Acute Physiology And Chronic Health Evaluation (APACHE) or Simplified Applied Physiology Score (SAPS) would adjust for these risk factors and allow comparison of different ICUs in the same hospital or different hospitals. Although not ideal, one could consider using data from a single ICU to evaluate the impact of the QI initiatives over time, if there is no significant change in the structure of the unit and assuming that the risk factors and patient population did not change significantly during the study period. As structural changes are resource intensive and would need a longer time, it would be more efficient initially to identify projects that affect processes.

An important consideration is to develop a concurrent database for quality data collection, since retrospective data collection is labour intensive. There are many evidence-based practices which improve outcomes, and a few examples with process and outcome measures are listed in Table 1. Some of the other QI measures that could be evaluated include family support and end-of-life care; use of low tidal volumes for acute lung injury; early and appropriate enteral nutrition; DVT prophylaxis and stress ulcer prophylaxis.

Conclusion

There can be no doubt that the assessment and improvement of performance will be a growing focus of the public. Physicians have a duty to drive forward informed and quantifiable measures that improve healthcare services. The Institute of Medicine in the US reported that there is a quality chasm in healthcare, and suggested that the delivery of healthcare should be improved so that it is safe, effective, patient-centred, timely, efficient and equitable. Both leadership and staff need to work together to achieve such a healthcare system, and intensivists are ideally suited for the job because of their experience. ■

Issues in Medical Education

Acute Care Undergraduate Teaching

Mariam Alansari MD, FRCSI
Consultant Intensivist
Intensive Care Unit
Salmaniya Medical Complex
Ministry of Health
Manama, Bahrain
dr_mariam5@hotmail.com

In most hospitals, medical services are overstretched and senior house officers (SHOs) in particular, have to spread themselves thinly over what is often a significant number of acutely ill patients. The traditional way in which many consultant physicians work, that does not involve significant components of acute care, adds to the complexity of the problem. Unlike the surgical on-call team, the medical team tends to divide itself, so that the consultant physician continues with elective outpatient work and is rarely involved in the acute admission process. Some physicians certainly have a close interest in acute medicine but maintain a distance from acute work.

As a result, doctors in training are both providing and leading the provision of acute care. The problem has recently been exacerbated in certain hospitals by restricting the role of interns on call. This has made them less available for training and, therefore, less experienced and confident than in the past. As a result, in complex cases, there is an inevitable risk that these doctors may provide care, which is less than optimal.

Problems Abound in Staffing for Acute Care

It may appear then that the solution is the provision of comprehensive and adequate critical care facilities to allow rapid admission of all sick and deteriorating medical patients. But here again there are problems with delays in review of patients and subsequent admission to intensive or high dependency care. In many of these cases the delay is related to a lack of critical care beds or staffing shortages, which result in significant numbers of beds actually being closed on a temporary basis.

However, provision of an appropriate environment for acute care is only part of the story. Severely ill patients often exhibit clear signs of clinical deterioration on the wards for some time, subjecting them to potentially avoidable in-hospital cardiopulmonary resuscitation if left undetected or ignored. Although nurses may pick up these simple clinical indicators and call for help, the inevitable delay resulting from SHOs working

Area of competence	Skills Required	
	Essential	Optional
Clinical examination, monitoring and investigations	Describes normal physiological ranges for basic vital signs including pulse, blood pressure, SpO_2, respiratory rate, urine output and body temperature. Demonstrates a systematic approach to the clinical assessment and timely management of the critically ill patient. Demonstrates safe handling and disposal of sharps and clinical waste. Demonstrates a systematic approach to 3- and 12-lead ECG interpretation, recognising common and important abnormalities. Demonstrates a systematic approach to chest X ray interpretation recognising common and life threatening abnormalities. Measures arterial blood pressure correctly using a manual method. Describes the importance of repeated and timely reassessment of the acutely ill patient. Demonstrates/describes how to obtain an arterial blood gas. Describes a systematic approach to arterial blood gas analysis. Describes the principles and limitations of pulse oximetry. Demonstrates the rationale use of common laboratory tests and investigations in the critically ill patient.	Describes the pathophysiological processes underlying critical illness. Describes the indications and complications of arterial line insertion. Demonstrates/describes how to perform urinary catheterization. Describes the principles and limitations of central venous pressure monitoring. Describes the principles and limitations of invasive arterial pressure monitoring.

Table 1: Example of proposed competencies for medical students at the point of graduation

largely on their own may further delay the instigation of appropriate treatment.

Earlier Intervention Would Lower Death Rates

Sub-optimal care before ICU admission is associated with higher ICU and hospital death rates. It is frequently related to poor management of simple aspects of acute care - those involving the patient's airway, breathing and circulation, oxygen therapy, fluid balance and monitoring. Other contributory factors include organisation failures, lack of knowledge, failure to appreciate the clinical urgency of a situation, a lack of supervision, failure to seek advice and poor communication. It is well documented that adverse events may be reduced by earlier intervention especially those provided by medical emergency teams. However, effective earlier intervention requires that staff is trained in the care of the acutely ill patient.

Undergraduates Should Learn More About Acute Care

Competence in caring for these patients should be a clearly defined component of undergraduate level curricula, in order to promote a culture of safe care for the acutely ill. Several previous studies have shown that resuscitation training is neglected in the undergraduate curriculum. To add to this problem, in recently developed courses used by some medical schools to educate undergraduates about acute care and resuscitation, consensus or common standard on this important aspect of student education is lacking.

It is therefore extremely urgent to first introduce these types of curricula in all undergraduate medical schools, and more importantly, use consensus techniques to identify those core competencies in the care of acutely ill patients that medical students should possess at the point of graduation. Recently consensus methods were developed, which could form the basis for an international standard for undergraduate training in acute care (Gavin D. et al). Table 1 summarises these proposed competencies for medical students at the point of graduation. ■

continued from p. 30

Failed Intubation – Different Recommendations

Recommendations of the different national societies differ significantly in their advice on best practice in managing an unpredicted difficult airway where oxygenation is still possible. In Table 1 you can see a few examples for comparison purposes.

Dealing with the Worst Case Scenario

If you cannot oxygenate your paralysed patient you will need guidelines and practice to avoid fatality. Despite the rarity of this scenario, it is the duty of the anaesthetist to know how to manage a 'cannot intubate' and 'cannot ventilate' scenario. In many cases, the disaster will have begun with a difficult mask ventilation and not directly with a 'cannot intubate' and 'cannot ventilate' situation. One of the most important reasons why this happens is that it has not been realised or accepted that this particular patient is impossible to intubate conventionally, and thereby the practitioner may continue to attempt intubation.

Table 2 shows different recommendations of how to manage a difficult mask ventilation that may potentially result in an airway disaster.

Conclusion

Despite the various recommendations published on how to manage a difficult airway, we must not forget that the steps involved in this critical treatment process will always be a practical matter that is subject to the individual variations of the situation. As anaesthetists and intensive care physicians, it is our obligation to gain and maintain the necessary skills, and to be prepared to manage rare life-threatening situations. As a consequence, the number of instruments should be limited to only a few proven techniques. These techniques should be used in the daily routine or at least in workshops. ■

Caring for the Obese Patient

Special Considerations in the ICU

Hans Ulrich Rothen, MD, PhD

Ludger Mende, MD

Department of Intensive Care Medicine
Bern University Hospital (Inselspital)
Bern, Switzerland
hrothen@insel.ch

In recent years, obesity has emerged as a major problem, both generally in terms of public health, and at a more personal level. Body mass index (BMI) is the ratio of weight for height, often used as a simple indicator of adiposity. A patient with a BMI of > 25 kg/m^2 is termed overweight, if the BMI is > 30kg/m^2 he is obese, and with a BMI > 40 kg/m^2 he is considered extremely or morbidly obese.

More than 60% of the inhabitants of the United States are overweight, with a still increasing trend in recent years. Accordingly, there was a six-fold increase over ten years in the number of bariatric surgeries in the United States, with more than 100,000 procedures in 2002. A similar trend is present in Europe, even though the overall prevalence of obesity is less than in the US. Recent studies suggest that this number is between 3% and 10%. In France, a prevalence of 12% was found for a BMI between 29 to 39 kg/m^2, and 0.5% for morbidly obese adults.

The increasing number of obese patients requiring critical care represents a challenge for intensivists. They must take into account specific changes in pulmonary and haemodynamic physiology, pharmacologic considerations and problems of nursing care. Of note, obese patients may have a prolonged length of stay in the ICU. Accordingly, such patients are at risk of a disproportionate, large use of resources.

Obesity: Associated Risks

Obesity is associated with a higher overall risk of death in all ages and in all racial and ethnic groups. The risk of in-hospital mortality and postoperative morbidity is increased. Obesity itself is an independent risk factor of mortality in ICU patients. Also, obesity was found to be an independent predictor of impaired postoperative outcomes after primary coronary artery bypass graft (CABG). Further, an increased number of wound infections and of acute onset of atrial fibrillation was found after CABG. Still, other studies show opposing results.

In a high number of obese patients, an increased incidence of hypertension, arteriosclerosis, coronary heart diseases, heart failure, and obesity cardiomyopathy is present. In addition, such patients may have insulin resistance or diabetes mellitus, and very often lipo-metabolic disorders are present. Obese patients also have an increased risk of postoperative thrombosis. Despite this, obesity in itself is not a significant predictor of acute organ failure or death. However, when obesity is combined with diabetes, a strong correlation was found for acute organ failure and death after acute organ failure.

Critical Care of the Obese Patient

Pulmonary management

Many obese patients suffer from obstructive sleep apnoea, obesity hypoventilation syndrome, and impaired gas exchange. The restrictive pattern of pulmonary function present in such patients is due to an abnormal position of the diaphragm, an increased mass of the chest wall, and an increased central blood volume. Overall, a close relationship between BMI and vital capacity (VC), total lung capacity (TLC) as well as residual lung volume (RV) is found.

For each unit increase in BMI, VC, TLC and RV decrease by about 0.5%. For functional residual capacity (FRC) and expiratory reserve volume (ERV), the changes are even more dramatic. For example, between a BMI of 20 to 30 kg/m^2, FRC and ERV decrease about 3% and 5% with each unit increase in BMI. The change in FRC is even more marked in the supine position and in the anaesthetised, mechanically ventilated subject. If FRC decreases below the volume of closing capacity, this will result in lung units that are poorly or not at all ventilated. Ultimately, such lung units will collapse and ensuing atelectasis will result in an increase of pulmonary shunt. These changes also may explain the shorter time to de-saturation during induction of anaesthesia, as observed in the morbidly obese.

Various procedures can prevent atelectasis or re-open collapsed lung tissue. For example, with an inflation of the lungs using an airway pressure of 30 – 40 cm H_2O, nearly all atelectatic lungs can be re-expanded. Of note, a time constant (t) of 2.6 seconds for the exponential decrease in amount of atelectasis was found when using a sustained inflation to an airway pressure of 40 cm H_2O. Thus, an inflation of the lungs to 40 cm H_2O maintained for no more than 7–10 seconds may re-expand all previously collapsed lung tissue in such patients.

A stepwise increase in PEEP also has been used as a recruitment manoeuvre. Finally, manual hyperinflation of the lungs might be used for such purposes. However, any disconnection from the ventilator exposed the lung to zero end-expiratory pressure (ZEEP), thus causing renewed collapse after attempted re-expansion. After a recruitment manoeuvre, PEEP significantly reduces the rate of renewed lung collapse even if a high FIO_2 is used. Finally, appropriate positioning helps to improve postoperative pulmonary function.

In many centres, fast-track recovery strategies are used to reduce the duration of ventilation and length of stay in the ICU. Of note, there may be a higher percentage of fast-track weaning failure following CABG in obese patients as compared to non–obese. Accordingly, a longer period of mechanical ventilation and a longer stay in the ICU has been observed in obese patients undergoing CABG. The use of nasal positive pressure ventilation may reduce the need for (re-) intubation and invasive mechanical ventilation. In any case, the intensivist should be aware of the possibility of difficult tracheal intubation.

Haemodynamic management

Obese patients have an increased total blood volume and an increased cardiac output and stroke volume at rest. On the other hand, such patients have an increased left ventricular pre- and after load, resulting in dilation and hypertrophy of the left ventricle. In addition, due to chronic hypoxia and hypercapnia, there often is pulmonary arterial hypertension and right ventricular enlargement and hypertrophy. As a result, obese patients suffer from poor exercise tolerance, pulmonary congestion and are at increased risk of right- and left ventricular failure.

Interpreting haemodynamic variables in obese patients can be difficult. In general, oscillometric (non-invasive) blood pressure measurements underestimate intra-arterial blood pressure. In otherwise healthy subjects, there is an increase in cardiac output and stroke volume with increasing BMI. Using cardiac index and stroke volume index, this seeming increase is markedly attenuated. Still, the ideal method of indexing haemodynamic parameters and the appropriate interpretation of such data remains a matter of debate.

Metabolism and Nutritional support

Obese patients have an increased basal insulin level. Accordingly, lipid mobilisation from body stores is suppressed and there is an increased breakdown of proteins to support gluconeogenesis. This, in turn, results in a loss of muscle mass. To enhance early enteral feeding, placement of a feeding gastrostomy tube should be considered. There is some evidence that hypo-caloric enteral feeding during the stay in the ICU may be superior to iso-caloric nutritional support.

Tight glucose control decreases the risk of wound infection and the risk of myocardial infarction during periods of myocardial ischaemia. Maintaining blood glucose at or below 110 mg/dL reduces morbidity and mortality among critically ill patients in the surgical ICU. Due to differing results in other studies, a unanimously accepted standard for treatment of hyperglycaemia in critically obese patients is still lacking.

Dosing of drugs

Most recommendations concerning appropriate dosing of drugs in obese patients are based on extrapolations from the limited information available in the literature or on personal experience. Importantly, due to variation in the apparent volume of distribution, protein binding, or elimination of a drug, and due to underlying co-morbidities, the pharmacokinetic effect of a specific drug very often cannot be predicted appropriately. Monitoring clinical endpoints such as the level of sedation will help the clinician to select an appropriate dose of a medicine. For some drugs the serum concentration should be obtained to ensure an adequate dosage. Finally, in specific situations, shorter dosage intervals may be needed.

Conclusion

To improve outcomes in critically ill obese patients, it is important to focus on measures to improve lung function. Accordingly, intensivists should:

- Recommend preoperative cessation of smoking;
- be aware of postoperative residual muscle blockage;
- use appropriate positioning (sitting or semi-recumbent);
- consider lung expansion techniques if atelectasis or its consequences are a relevant clinical problem;
- be aware of a difficult re-intubation;
- consider intensive insulin therapy;
- be aware of cardiovascular risks; and
- use prophylaxis of deep vein thrombosis.

Finally, a multi-modal approach including appropriate anaesthesia and analgesia will help improve outcomes in obese patients and shorten lengths of stay. ■

For references please write to:
editorial@icu-management.org

Bjørn Magne Eggen
Director of the Clinic of Medicine,
Akershus University Hospital,
Lørenskog, Norway

An Overview of Healthcare in Norway

Organisation of the Healthcare System

More than 85% of all healthcare expenditures are publicly covered. The 431 municipalities/communes, with population size ranging from 250-500,000 inhabitants, have been responsible for the primary health and care services since 1984. Almost every MD in general practice participates in the regular general practitioner scheme (termed "fastlege" in Norwegian). Since 2002, the state covers all the specialised health services through four regional health authorities. More than 90% of all hospital beds in Norway are in the 80 state-owned hospitals, organised as 31 health enterprises.

Communes finance home care and social services while GP services have a combined financing; from the communes (block granting, dependent upon number of enlisted patients), fee-per-service paid by the patients directly and by the national social benefit programme. The specialised health service has a combined financing; the psychiatric services are block (grant) financed, while somatic services are partially (60%) block financed and 40% fee-for-service financed.

In the Norwegian health and care services, patients have freedom to choose hospital nationwide, with total coverage from the state programme; the patients themselves pay only a small part of travel expenditure (up to 100 EUROS for each hospital stay) if they choose a distant hospital. ■

Norway: Facts & Figures	
Population:	4.7 millions inhabitants
Area:	323,700 square kilometres (North – South distance: 2,500 km)
Language:	Norwegian (with two official forms), and Lappish
Capital:	Oslo
Total GDP:	NOK 2,170,000,000,000 (approx. 271,000,000,000 EUROS)
GDP per capita:	NOK 461,665 (approx. 57,700 EUROS)
Healthcare spending:	NOK 150,000,000,000 in total; NOK 31,800 (4,000 EUROS) per capita; 9.7% of total GDP (2005).
Health Care Professionals:	Total 212,000; 15,135 medical doctors; 25% in General Practice (GP).
Amount of professionals in primary care services:	55%
Amount of healthcare spending in primary health services:	36.1%
Average life expectancies:	81.9 years (women) 76.9 years (men)

Critical Care in Norway

Treatment of the critically ill is usually only infrequently debated in public in Norway. However, in the last two years there have been a few ICU cases that have generated a large amount of public interest in Norway. In these cases, the issue usually stems from a conflict between ICU physicians and relatives regarding ending life sustaining treatment. ICU physicians advise ending treatment, but the relatives-often parents, refuse to accept this. In the process, lawyers and media (newspapers and radio/television) become involved, inflaming and complicating these issues.

The most well known incident was the "Kristina-case" named after a 4-year critical ill girl. After a substantial rainfall in 2005, she was a victim of a mud-avalanche on her family's home outside Bergen. Her mother died as a result, but her father, and a brother and sister survived. She was found submerged in mud after approximately one hour, but was initially resuscitated. Unfortunately, she suffered severe hypoxic cerebral damage, and did not regain consciousness. She also was ventilator dependent, but had blood supply to the brain.

After internal discussion and utilising second opinions of external experts, the medical team at Haukeland University Hospital advised ending ICU treatment, but her father resisted. The local health authorities supported the hospital's decision. Still the disagreement continued, and her case was taken to court in early 2006. It was the first time in Norwegian justice history that a case was before the courts during continuing ICU treatment. The court also supported the hospital's decision, but the verdict was immediately appealed.

In February 2006, after 5 months of intensive care the hospital turned off the ventilator against the fathers will. Following this action, expert groups re-investigated the treatment given to her in hospital. The final group, an international expert panel, reached their verdict this summer and the hospital received full support of its actions. This case was extensively documented and followed by various media, including being a topic in several television debates. Politicians have also voiced their opinions, most strongly supporting her father, stating that he (and parents in general) should be responsible for making such a decision, not the doctors.

So the debate continues as to who should have the final word when relatives and doctors do not agree about life sustaining treatments. Most agree that communication is a key point, and that in most instances, good communication over time will solve discrepancies and foster agreement, but as we have experienced, this does not always happen.

After the Kristina-case, the medical community in Norway acknowledged several general questions that this case raised:

- **What are the precise definitions of coma, chronic vegetative status and related terms and are they agreed by all medical specialties?**
- **What is the gold standard for objective testing regarding impaired consciousness and coma in adults and children?**
- **How should we utilise second opinions in a small country like Norway?**
- **What is the role of lawyers and courts in the decision-making process?**
- **What are the ethical issues regarding withdrawing or withholding life-sustaining therapy?**

The Norwegian Medical Association established a working group to examine these issues in Autumn 2006. The Norwegian Directorate for Health and Social Affairs also decided to create national guidelines regarding withdrawal of life-sustaining therapy earlier this year after it became known that only five Norwegian ICUs had written guidelines on how to proceed regarding ending ICU treatment in the case of futility. Some politicians and one political party wanted to implement a new law, stating that stopping ICU treatment was not possible without consent from relatives. Such a law was voted down in the Norwegian Parliament, but new guidelines are expected.

At present, the discussion is focused on second opinions and whether a clinical ethical committee at another hospital should routinely intervene in cases where there is disagreement between physicians and relatives. However, as was illustrated this summer (2007), when there was a dispute in another case, this can be challenging in practice. Ethical committees are often difficult to summon on short notice, since in Norway they have more often worked with cases in retrospect or "general" medical ethical issues, not with ongoing cases.

These discussions have brought other issues to the forefront, namely intensive care capacity in Norwegian hospitals. Overall, the number of ICU beds is low in Norway with only 1 - 2% of the total hospital beds in university and regional hospitals. In addition, many hospitals lack sufficient step-down units, making the pressure on ICU beds very high. This debate will hopefully lead to a national discussion about the dimensions and aims for Norwegian intensive care in general. But presently a national plan or guideline regarding intensive care fails to exist. This is surprising given that one day of intensive care in ICU in Norway costs around 4000 (euros), and is among the most expensive treatments administered. ■

Hans Flaatten
Medical Director and Professor
Intensive Care Unit
Haukeland University Hospital
Bergen, Norway
hans.flaatten@helse-bergen.no

Professional Life in Norwegian Intensive Care

Pål Klepstad MD, PhD
Medical Director
Department of Intensive Care
St Olavs University Hospital
Trondheim, Norway
pal.klepstad@ntnu.no

Physicians Working in Norwegian ICU Care

A key issue in Norwegian ICU care is how to give adequate ICU treatment to all patients despite a scattered population and geographically and meteorologically challenging conditions for patient transfers. These conditions necessitate that many patients are treated at local hospitals in relatively small ICU units. These compact ICU units are usually combined intensive care and postoperative care units. In the smallest hospitals, ICU is also organised together with coronary care units.

Additionally, these hospitals often do not have the ability to employ the number of specialised ICU physicians needed for 24-hour ICU physician's coverage. Therefore, intensive care medicine is performed at most of the hospitals by anaesthesiologists, who are involved in all four of the traditional four medical themes of Norwegian anaesthesiology; anaesthesiology, emergency medicine, pain medicine and intensive care medicine. This training ensures that small hospitals will have sufficient support for treating critically ill patients. In these hospitals the professional life of the physicians delivering ICU care includes combining ICU medicine with several other medical duties.

However, patients requiring multidisciplinary or specialised intensive care (i.e. paediatric intensive care) are transferred to tertiary ICU departments at university hospitals. During the last decade there is an emerging trend that in several of the university hospitals anaesthesiologists specially trained in intensive care medicine exert this competency on a full-time basis. Norwegian physicians working full-time in intensive care units are certified anaesthesiologists. To date there is no formal mandatory certification to become an intensive care physician, but in recent years most doctors entering the field are following the Scandinavian Society for Anaesthesiology and Intensive Care training programme in Intensive Care Medicine and complete the European Diploma of Intensive Care Medicine.

Norwegian ICU Recruitment

As anaesthesiologists almost exclusively deliver ICU care in Norway, there is no specific fast track professional road into the ICU directly from medical school. While studying to become a certified anaesthesiologist, at least six months of residency should be performed in an ICU, three of which should be in a university hospital. In addition, most anaesthesiologists will be allocated to ICU work for a large part of their in-house on-call duty. Thus, all anaesthesiologists in Norway are quite familiar with ICU work tasks. Most physicians working in Norwegian ICUs began with the aim of becoming general anaesthesiologists and developed a special interest in intensive care medicine during their training. There is no formula for which trainees will be recruited to the ICU; senior staff generally decides who they believe are most suited for the positions. In my hospital, ICU care seems to be popular amongst anaesthesiology trainees and a number of physicians express an interest in pursuing a career as full-time ICU physicians. Recruitment of physicians is not a problem for me as Medical Director in fact I sometimes have to turn down promising candidates.

Norwegian ICU - Professional Environment

Norwegian ICU units are organised as closed units with most treatment decided on and delivered by ICU physicians. Of course, treatment is given in collaboration with the department that referred the patient into ICU care, for instance, surgeons who decide part of the treatment related to surgical procedures. Also the role of the ICU physician is frequently to bring other specialist doctors into the unit; some frequent examples from my own unit are infection specialists, microbiologists, nephrologists or haematologists.

Norwegian ICU physicians work closely together with the ICU nurses. Norwegian ICU nurses are educated though an educational programme of 18 months offered to registered nurses. For most ICU departments, the majority of nurses have this ICU specialisation. In addition, large ICUs also employ physical therapists. The high educational level of co-workers in ICUs makes patient treatment a multidisciplinary effort. While the chain of medical command is undisputed, a multidisciplinary approach results in the working environment becoming more about discussions and consensus than medical paternalism.

The situation with regards to medical equipment is relatively good in Norwegian ICUs. Departments have modern ventilators, syringes pumps, monitors and those treating patients with severe organ failure can deliver continuous renal replacement treatment. Some treatments are centralised to one department; examples are severe burns, ECMO and MARS treatment. The trend for centralisation is rooted not in economics but more in the need to have a large enough patient population in order to get the appropriate level of training. So while medical directors in Norwegian ICUs have to argue for the need for new equipment and to know hospital politics, the end result is generally a nicely equipped ICU. An exception to this is the use of electronic patient records, which are presently

continued on p. 41

An interview with
Nils Smith-Erichsen

Dr. Nils Smith-Erichsen is a Consultant in the ICU at Akershus University Hospital in Oslo, Norway. He shares his views on Intensive Care in Norway.

Please tell us about your experiences working as an intensivist in Norway.

When I began as a full-time intensivist in 1979, only a few colleagues were in the same position in Norway. I trained as an anaesthesiologist at Rikshospitalet University Hospital and my interest in intensive care started during this period. The unit is a section of the department of anaesthesia at Akershus University Hospital, a secondary care hospital located 20km north-east of Oslo. It is a general ICU with 10 beds. We serve all specialties except cardiac surgery and neurosurgery. The unit is staffed with three doctors; one full-time, one 80% and myself 60% (40% of my time is devoted to my university function) as well as 80 nurses of whom 50 are working full-time, in addition to two assistants and one secretary. In 2006, we treated 473 patients, 60% of whom were in need of mechanical ventilation.

How many intensive care units are currently operating in Norway? Are there any areas of high demand in the ICU?

According to the Norwegian Intensive Care Registry (NIR), 31 units report data to the registry. In 2005, 8,259 patients were treated in 28 Norwegian ICUs according to NIR. These patients generated 40,880 ICU days and 23,440 ventilator days. Approximately 10,000 patients are treated in Norwegian ICUs per year, or about 0.2% of the Norwegian population. The most demanding group in our ICU are patients with severe infections. In recent years, the number of elderly patients, patients with haematological malignancies and those with severe co-morbidities have increased demand on ICU facilities.

What technological advances in Norway are making ICU services more efficient?

The introduction of continuous renal replacement therapy and the development of more sophisticated ventilators have made intensive care more efficient in recent years. The increasing use of syringe pumps for continuous medication has also contributed. In our unit, the introduction of a patient data management system (PDMS) in 2000 has

continued from p. 40

available in only a few Norwegian ICUs. However, in many departments, including the ICU at our hospital, the age of electronics is currently invading the departments with electronic patient records, electronic systems for medical imaging and electronic handling of administrative patient data.

Daily Issues for Norwegian ICU Professionals

The most pressing ICU issue in Norway as in most other countries is the discrepancy between available number of ICU beds and patients requiring ICU treatment. In my department, many days we struggle with both diverting new patients and transferring patients to other wards or hospitals. There is a fine line in practicing quality medicine with the continuous risk of allowing the lack of ICU beds to endanger patient safety. One factor contributing to this situation is that in most Norwegian hospitals ICU funding is not based on the number of patients treated but rather to a fixed budget given by the hospital. Thus, there are no economic incentives to treat more patients.

Another constraint experienced by colleagues is the limited resources allocated for clinical ICU research. This is partly caused by lack of funding, but perhaps even more by the day-to-day demand of clinical work tasks, which give little time available for research. The limited clinical research has for the last years been enhanced by the recent Biobank Act that prevents healthcare workers from obtaining a biological sample from patients who are not able to give informed consent. As ICU patients in general lack the ability to give a qualified informed consent this has stalled most ICU Norwegian clinical research for some years. Luckily, the Biobank Act has recently been revised and it is now possible to obtain consent from next-of-kin or deferred consent from patients participating in a clinical ICU study. ■

been the most important tool. Akershus University Hospital was the first to implement such a system in Norway. Finally, I anticipate that the introduction of specialised ICU beds will also help.

Is cost-effectiveness a focus for Norwegian ICU?

There is a continual demand for reducing costs in intensive care in all Norwegian hospitals, however only minor attention is devoted to how efficiently available resources are used. NIR use the Nine Equivalents of Nursing Manpower use Score (NEMS) as a measure of resource use in intensive care (Miranda 1997). This score can be correlated to nurse workload and costs as a measure of efficiency. Efficiency measures are not yet a focus of NIR. We have used it in our hospital on a project basis, but not published any data. To my knowledge, only three studies from Norway have been published. Two of them are cost-benefit studies calculating the cost of intensive care and the cost per expected year of survival for survivors (Thoner 1987, Løes 1987). The third study is an average cost-effectiveness study using the expected remaining years of survival in survivors after 18 months (Flaatten 2003). According to Flaatten, personnel costs comprise about 65% of total costs of intensive care.

Is there any noteworthy research in the field of ICU taking place in Norway?

There are ongoing clinical studies on long-term results after intensive care under the guidance of Professor Hans Flaatten at Haukeland University Hospital in Bergen in western Norway. Both clinical and experimental studies of high quality are going on at Ullevaal University Hospital in Oslo under the guidance of Professor P.A. Steen. His special field of interest is clinical and experimental research on cardio-pulmonary resuscitation. At the University Hospital in Northern Norway in Tromsø, Professor Lars Bjertnaes and his group have been doing experimental studies on acute lung injury in a sheep model for several years.

How is education for intensivists organised in Norway?

The Norwegian system of postgraduate specialisation for physicians incorporates anaesthesia and intensive care in one specialty. After passing their final exam, medical students must do a one-year postgraduate internship in internal medicine and general surgery, followed by six months in general practice under the guidance of a general practitioner. Once they have received their medical license, they can start their specialisation in anaesthesia and intensive care in selected certified hospitals where a minimum of a year and a half must be in a university clinic. To become a specialist requires an additional four and a half years in anaesthesia and intensive care and six months in a medical or paediatric department. During the training period candidates must go to educational courses for 260 hours of which 222 hours are obligatory. At the end of each course candidates must pass an exam to obtain certification. The title 'specialist in anaesthesiology', is granted after application to the Norwegian Medical Association.

Does Norway experience any problems in centralising services for isolated communities?

Norway has about 40 acute care hospitals to cover a population of about 4.6 million people. Two thirds of the population lives in the southeast area of Norway while the remaining third resides in the western and northern regions. Our nature and climate makes communication difficult in some areas, particularly during autumn and winter months. As a result, it is sometimes necessary for hospitals to confirm that patients can reach hospital within reasonable time. Therefore, only advanced healthcare services, such as organ transplant, open-heart surgery and rare diseases have been centralised. The question of centralising more common healthcare services is now on the agenda and is discussed among the public, medical personnel and politicians, as the hospital is an important employer in some communities.

How is reimbursement for ICU services organised in Norway?

The ICU has its own budget, based on that of the department of anaesthesia and the hospital's budget as a whole. The hospital budget is partly based on a fixed sum from the government and an activity-dependent reimbursement. Hospital activity is measured by DRG. This is valid for the vast majority of Norwegian hospitals, which are publicly-funded. There may be exceptions for a few private hospitals, but I believe they also receive their major funding from the government.

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Lifetime Achievement Award Winner **Arthur E. Baue, MD** Professor Department of Surgery St. Louis University School of Medicine St. Louis, Missouri, US **Plenary: From SIRS to MODS to MOF in the ICU** Sunday, February 3, 2008	**Makoto Suematsu, MD** Professor Department of Biochemistry and Integrative Medical Biology Keio University School of Medicine Tokyo, Japan **Plenary: Biomedical Application of Metabolome Analysis: Grasping Energy Metabolism as a Whole** Monday, February 4, 2008	**David J. Pierson, MD** Professor Pulmonary and Critical Care Medicine Harborview Medical Center University of Washington Seattle, Washington, US **Plenary: The Cardiopulmonary Physiology of Dinosaurs** Monday, February 4, 2008
Jamie Cooper, MD Deputy Director ICU Alfred Hospital Melbourne, Victoria, Australia **Plenary: Traumatic Brain Injury** Tuesday, February 5, 2008	**Joseph F. Dasta, MSc, FCC M** Professor College of Pharmacy The Ohio State University Columbus, Ohio, US **Plenary: Drug Costs in the ICU: More Than Meets the Eye** Tuesday, February 5, 2008	**Thomas P. Bleck, MD, FCC M** Professor Department of Neurology Evanston Northwestern Healthcare Evanston, Illinois, US **Plenary: Neurological Critical Care** Wednesday, February 6, 2008

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The EPIC II Study

Jean-Louis Vincent
Department of Intensive Care
Erasmus Hospital
Free University Brussels
Brussels, Belgium

MAY 8, 2007
EPIC
STUDY II
Extended Prevalence of Infection in Intensive Care

On April 29, 1992, the European Prevalence of Infection in Intensive Care (EPIC) study collected data from more than 10,000 intensive care unit (ICU) patients in 17 countries in Western Europe (Vincent et al. 1995). This one-day point prevalence study investigated the prevalence of ICU-acquired infections, risk factors for these infections, the predominant infecting organisms, patterns of antimicrobial resistance, and the relationship between ICU-acquired infection and mortality. The results from EPIC provided a key epidemiologic source of reference for the status of nosocomial infection in Europe at that time.

On May 8, 2007, EPIC II (The Extended Study of Prevalence of Infection in Intensive Care) was conducted to provide an updated epidemiological database on infection in the ICU, 15 years after the original EPIC. Importantly, EPIC II was extended from Europe to the rest of the world and has been a substantial success with more than 2,000 ICUs participating, and more than 10,000 patients registered. Figure 1 (see below) shows those countries with the greatest number of participating ICUs, but we have also had patients registered from many other countries, including Yemen, Malta, Nigeria, … even the Solomon Islands! The EPIC II database will allow us to address a number of fundamental questions related to the presence of ICU infection throughout the world, and will lead to a number of publications. Such epidemiological information is vitally important in increasing and maintaining awareness of the impact of ICU infection, in developing local and international management policies for infection diagnosis and treatment, and in ensuring adequate resource allocation.

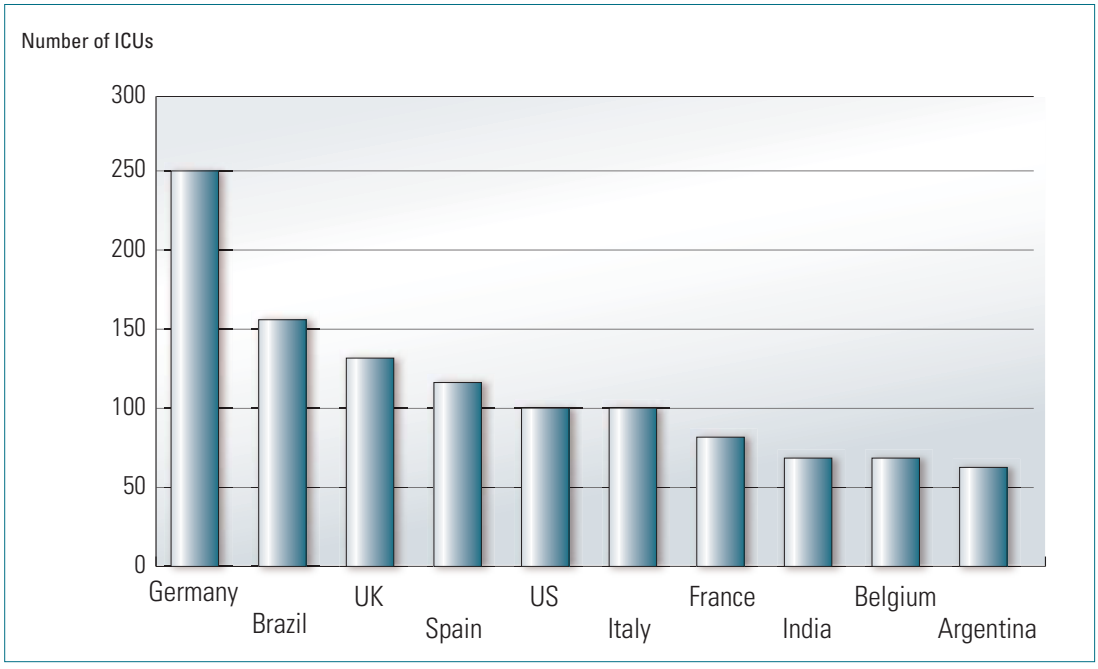

Figure 1. The ten countries with the largest number of ICUs contributing patients to the EPIC II study.

Data from this exciting collaborative project is still being collected, notably for patient outcome, but we are already beginning to analyse the preliminary results and the initial data will be presented at the ESICM meeting in Berlin this year.

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17-21 8th Pan American and Iberic Congress of Intensive and Critical Care Medicine
Punta del Este, Urugruay
www.mcti2007.com

28-30 Asian Intensive Care: Problems & Solutions
Hong Kong, China
www.aic.cuhk.edu.hk/web8/Conference.htm

DECEMBER 2007

4-7 Therapeutic Temperature Management Congress
Cancun, Mexico
www.ttmcongress.com

JANUARY/FEBRUARY 2008

27-1 16th Winter Symposium on Intensive Care Medicine
Steamboat Springs, Colorado, US
www.intensive.org

2-6 Society of Critical Care Medicine's 37th Critical Care Congress
Honolulu, Hawaii, US
www.sccm.org

MARCH 2008

18-21 28th International Symposium on Intensive Care and Emergency Medicine
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ICU MANAGEMENT
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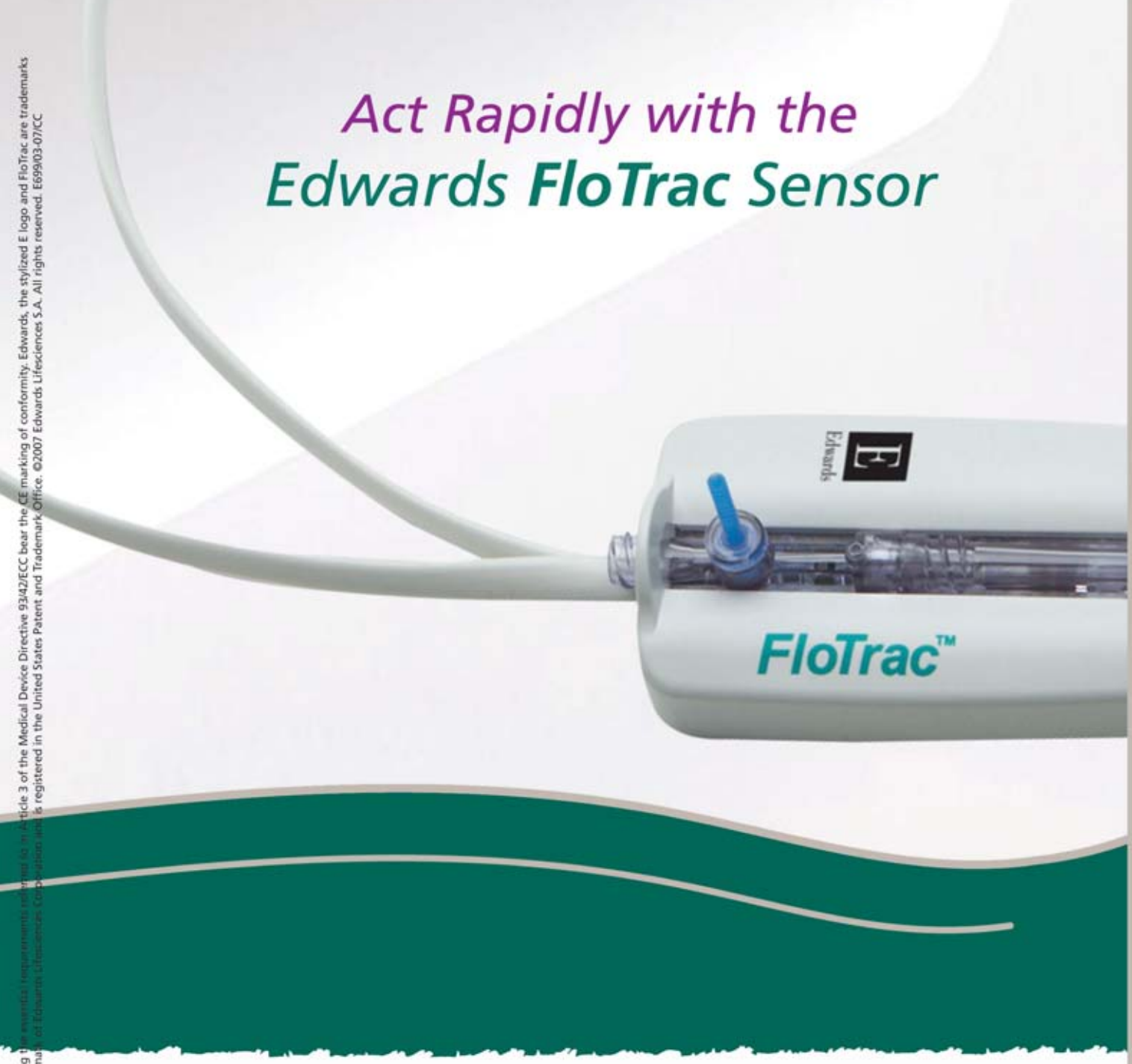

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