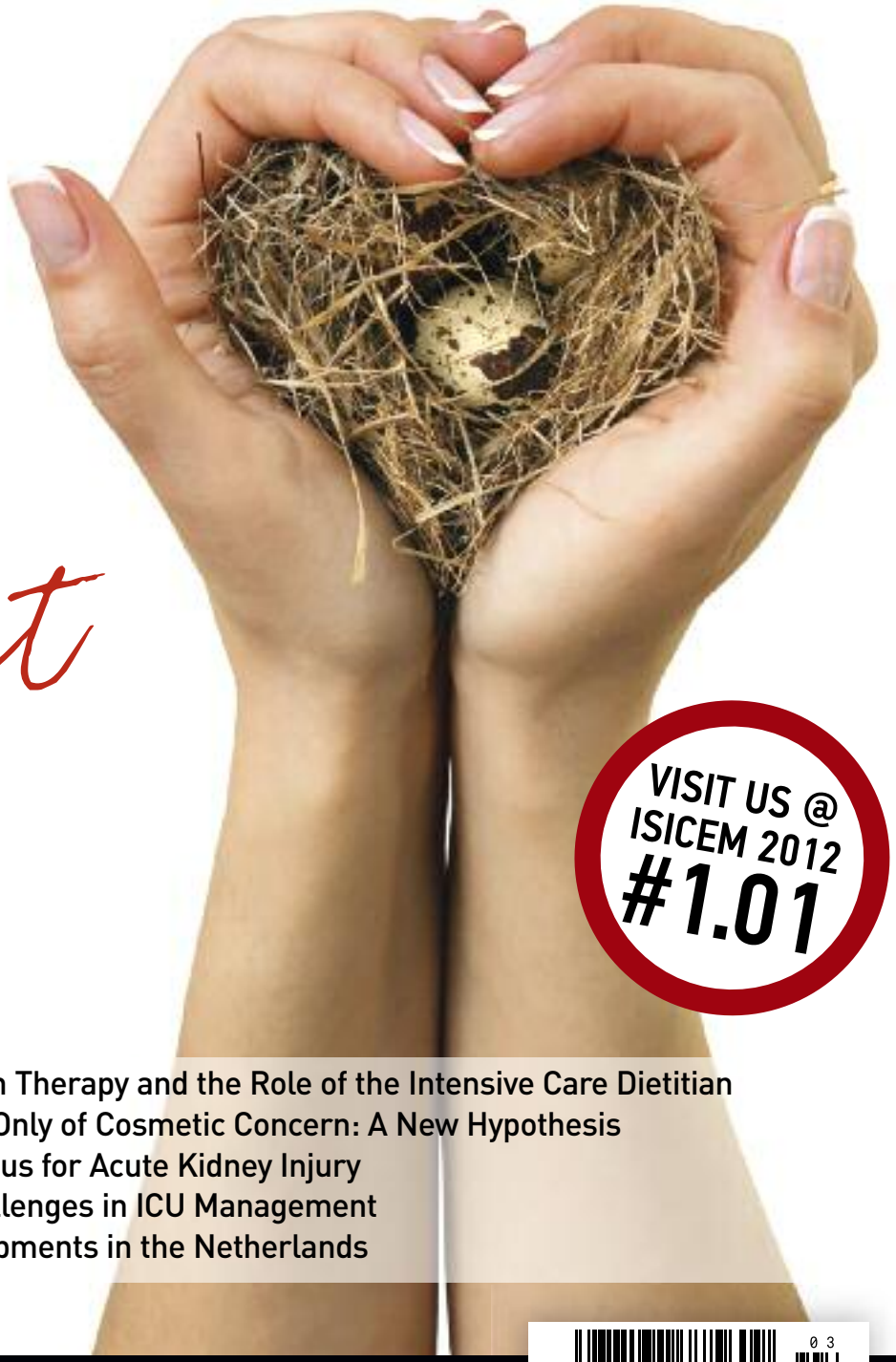
ICU MANAGEMENT

THE OFFICIAL MANAGEMENT AND PRACTICE JOURNAL

VOLUME 12 - ISSUE 1 - SPRING 2012



the Perfect ICU

VISIT US @ ISICEM 2012 #1.01

PLUS:

- Excellence in Nutrition Therapy and the Role of the Intensive Care Dietitian
- Fluid Overload is Not Only of Cosmetic Concern: A New Hypothesis
- An Emerging Consensus for Acute Kidney Injury
- Past and Present Challenges in ICU Management
- Intensive Care Developments in the Netherlands

0 977137 775609 03

ORION PHARMA

INTRODUCING A NEW ERA IN ICU SEDATION:

Effective sedation. Effective response.

Depend on dexdor®:

- Maintain light-to-moderate sedation[1]
- Improve patient manageability[1]
- Facilitate better patient communication[1]
- Decrease time to extubation[2]

dexdor®
(dexmedetomidine hcl) injection

Cooperative comfortable sedation

1. Ruokonen E et al. Intensive care med 2009; 35:282-290.
2. Riker RR et al. JAMA 2009; 301(5):489-99.

Indication: Sedation of adult ICU patients requiring sedation level not deeper than arousal in response to verbal stimulation (RASS 0 to -3). Dosage and administration: Hospital use only, by healthcare professionals skilled in management of patients requiring intensive care. Administer only as diluted intravenous infusion using controlled infusion devices. Dexmedetomidine is very potent and the infusion rate is given per hour. Switch patients already intubated and sedated to dexmedetomidine with initial infusion rate of 0.7 microg/kg/h and adjust stepwise within range 0.2 to 1.4 microg/kg/h to achieve desired sedation level. Consider lower starting infusion rate for frail patients. After dose adjustment, new steady state sedation level may not be reached for up to one hour. Do not exceed maximum dose of 1.4 microg/kg/h. Switch patients failing to achieve adequate level of sedation with available opioids or other sedative agents. Loading dose not recommended. Administer propofol or midazolam if needed until clinical effects of *dexdor*® established. No experience on use of *dexdor*® for more than 14 days. Use for longer than this period should be regularly reassessed. Elderly: No dosage adjustment required. Renal impairment: No dosage adjustment required. Hepatic impairment: Caution advised; consider reduced dose. Children aged 6-18 years: Safety and efficacy not established. Contraindications: Hypersensitivity to dexmedetomidine or the excipients. Advanced heart block (grade 2 or 3) unless paced. Uncontrolled hypertension. Acute cerebrovascular conditions. Warnings and precautions: Intended for use in intensive care setting, use in other environments not recommended. Continuous cardiac monitoring required. Monitor respiration in non-intubated patients. Do not use as induction agent for intubation or to provide sedation during muscle relaxant use. *dexdor*® reduces heart rate and blood pressure but at higher concentrations causes peripheral vasoconstriction and hypertension. Not suitable in patients who will not tolerate lack of deep sedation and airway instability. Users should be ready to use alternative sedative for acute control of agitation or during procedure, especially during the first few hours of treatment. Caution with: pre-existing bradycardia; high physical fitness and slow resting heart rate; pre-existing hypotension, hypovolaemia, chronic hypoexcretion or reduced functional reserve, severe ventricular dysfunction; the elderly; impaired peripheral autonomic activity (e.g. due to spinal cord injury); ischaemic heart disease or severe cerebrovascular disease; severe hepatic impairment; severe neurological disorders such as head injury and after neurosurgery. Reduce dose or discontinue if signs of myocardial or cerebral ischaemia. Additive effects may occur with other substances with sedative or cardiovascular actions. Some patients receiving *dexdor*® have been observed to be arousable and alert when stimulated; this alone should not be considered as evidence of lack of efficacy. Do not use as sole treatment in status epilepticus. Consider possibility of withdrawal reaction if patient develops agitation and hypertension shortly after stopping dexmedetomidine. Not recommended in malignant hyperthermia-sensitive individuals. Discontinue treatment in event of sustained unexplained fever. Undesirable effects: Very common (≥1/10): Bradycardia, hypotension, hypertension. Common (≥1/100 to <1/10): Hyperglycaemia, hypoglycaemia, agitation, myocardial ischaemia or infarction, tachycardia, nausea, vomiting, dry mouth, withdrawal syndrome, hyperthermia. Uncommon (≥1/1,000 to <1/100): Metabolic acidosis, hypokalaemia, hallucination, atrioventricular block first degree, cardiac output decreased, dyspnoea, abdominal distension, drug ineffective, thirst. See SPC for further details. Pack sizes: 5 x 2 ml ampoules; 25 x 2 ml ampoules; 4 x 10 ml vials. Marketing authorisation holder: Orion Corporation, Orionintie 1, FI-02200 Espoo, Finland. *dexdor*® is a registered trademark. Date of Prescribing Information: Sep 2011.

www.dexdor.eu

THE PERFECT ICU

Jean-Louis Vincent

Editor-in-Chief
ICU Management

Head
Department
of Intensive Care
Erasme Hospital / Free
University of Brussels
Brussels, Belgium

jlvincen@ulb.ac.be

A disheartening moment in any medical department, particularly in the critical arena, is that of unforeseen human error leading to injury. With teams doing their utmost to ensure the best chances of survival for patients, the inevitability of occasional mistakes occurring in what is an immensely complex system is a distressing concept to shoulder. The emphasis here is that these events should occur rarely; thus, whatever can be done to mitigate them has become a significant focus of research and development.

Increasing quality of care and the effectiveness of the ICU is recognised to be as important as the elected treatment for individual patients. Even mistakes that appear insignificant can influence the entire process, adversely affect a patient, and sometimes result in dire consequences. A prominent view is that many errors that occur could be avoided; therefore, new approaches to management and reorganised structures have finally begun to surface in ways that could bring ICUs to function at their optimal performance.

In this issue of ICU Management, Dr. Ken Catchpole and his team provide us with a detailed overview of their response to research that showed a surprising frequency of accidental injury in healthcare. They explain the ways in which the team at Great Ormond Street Hospital adapted the efficient processes of Formula 1 pit stops to apply to ICU handovers, and they share the challenges they faced. As in any change process, some degree of resistance was experienced and authors describe the people-centred approach that was taken to foster buy-in to the modifications.

Both ICU staff members and patients are important in formulating a successful change process, something which Drs. Jozef Kesecioglu and Margriet Schneider have explored in great detail. Their case study of patient- (and family-) centred care, matched with functionality, safety and innovation is inspirational, impelling change in all areas of the ICU. Whether there is in fact such a thing as the perfect ICU, is an idea that Ed Matthews and Gianpaolo Fusari refer to in their piece that explores the transferral of ambulance design innovation into the ICU context, further ingraining the notion that whether from aviation, Formula 1, or ambulances, adopting efficient processes can help to improve the ICU.

To begin our Nutrition series, Dr. Daren Heyland and Dr. Emma Ridley, with their team of specialists, describe methods by which provision of nutrition therapy to critically ill patients may be improved. In doing so they brief us on lessons that have been learnt from the International Nutrition Survey and the Best of the Best awards, and how recognition and reward programmes can play a part in raising standards. Dr. Ludivine Soguel is part of a professional trio who zone in more specifically on the role of the ICU dietitian, highlighting the integration that is required to become an efficient dietitian in the intensive care field.

Previously we were introduced to the topic of non-invasive helmet ventilation and its clinical applications, whereas in this issue we investigate the innovative field further. Dr. Fabrizio Racca leads a team who provide recommendations on helmet use along with advantages and disadvantages that should be recognised. Our Matrix section then leads on to another stimulating article, explaining the potential detrimental side effects of fluid overload. Within their report, Dr. Manu Malbrain and Dr. Niels Van Regenmortel indicate that a variety of strategies are available to the clinician to reduce the volume of crystalloid resuscitation utilised while restoring macro- and microcirculatory flow. Finally, Dr. Mary Seddon delivers a detailed methodology of the multi-faceted quality improvement programme that was implemented in the ICU of New Zealand's Middlemore Hospital to reduce incidents of Central Line Associated Bacteraemia (CLAB), including how a clinician buy-in was forged.

A hot topic in the current arena is acute kidney injury (AKI), with new guidelines from Kidney Disease: Improving Global Outcomes (KDIGO) having been published in March. The emerging consensus of AKI is tackled by Drs. John Kellum, Claudio Ronco and Michael Joannidis in our Viewpoints section, delivering an esteemed update. This is followed by a descriptive article from Prof. Jukka Takala, which emphasises past challenges that have helped ICU's foster improvements, ranging from those in personnel, to those in technology, and material resources.

The issue is rounded off with an overview of the Dutch healthcare system, with a focus on intensive care. The Dutch Society of Intensive Care celebrates its 35th anniversary this year, inspiring a summary of past achievements and evolution to the present day from Dr. Peter de Feiter and his colleagues.

Past challenges and an enhanced culture of continuous improvement in all areas of the ICU have not only helped to innovate treatments provided to patients, but have improved management processes, reducing dire errors, and helping to create a more tranquil and beneficial atmosphere in the critical care department. The learning curve has been further boosted by the more broadly accepted notion that methods from other countries as well as diverse professional fields can help in improving the effectiveness of ICU's and thus the wellbeing of their patients.

Please send your responses to me at **editorial@icu-management.org.**

Jean-Louis Vincent

Join us in 2013

33rd International Symposium on Intensive Care and Emergency Medicine

BRUSSELS MEETING CENTER (SQUARE)

MARCH 19-22, 2013

Hôpital Erasme | ULB

CME Accreditation

Plenary Sessions, Mini-Symposia,
Workshop, Technical Forums, Round Tables, Tutorials, Posters

Endorsed by:

European Society of Intensive Care Medicine
Society of Critical Care Medicine
American Thoracic Society
European Society for Emergency Medicine
European Shock Society
The Institute of Critical Care Medicine
The Canadian Critical Care Society
Australian and New Zealand Intensive Care Society
International Pan Arab Critical Care Medicine Society
World Federation of Societies of Intensive and Critical Care Medicine
International Sepsis Forum

Meeting Chairman: JL Vincent
Email: jlvincen@ulb.ac.be

Manager: V De Vlaeminck
Email: veronique.devlaeminck@ulb.ac.be

Dept of Intensive Care,
Erasme University Hospital
Route de Lennik, 808,
B-1070 Brussels, Belgium

Phone 32.2.555.32.15/36.31.
Fax 32.2.555.45.55
Email: sympicu@ulb.ac.be

Website: http://www.intensive.org

Deadline for abstract submission: December 15, 2012

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.

RESEARCH NEWS

Immune System Tricked to Accept Mismatched Donor Organs

A group of scientists have found a method for deceiving the immune system so that it will accept organs from an incompatible donor, a finding that could help patients avoid a lifetime of medication to prevent rejection of the organ.

The procedure involves suppressing the patient's bone marrow with chemotherapy and radiation before they undergo surgery; a day later they are transplanted with the donor's bone marrow. The idea here is to try to use donor-derived stem cells to achieve engraftment. About a month before transplant surgery, kidney donors must inject themselves with a medication for several days to force stem cells and facilitating cells into their bloodstream, so that engraftment can occur more safely.

Of eight kidney transplant patients who have been treated with this new approach, five have been able to avoid taking anti-rejection drugs a year after their surgery, according to the study.

Dr. Suzanne Ildstad, Director of the Institute of Cellular Therapeutics at the University of Louisville in Kentucky, who developed the new approach, said in a statement: "This new approach would potentially offer a better quality of life and fewer health risks for transplant recipients."

However, some experts say the procedure is risky, and unnecessarily so given the relative safety of kidney transplants.

Dr. Tatsuo Kawai, a transplant surgeon at Harvard Medical School, who wrote a commentary on the new approach in the journal, said: "We have to think about the risks and benefits. Since the current treatment is so stable, it really has to be safe."

The study is the first to try to create chimeric tolerance in patients using the facilitating cells created by Regenerex.

www.sciencedaily.com

Journal Reference:

Ildstad S (2012) Chimerism and Tolerance Without GVHD or Engraftment Syndrome in HLA-Mismatched Combined Kidney and Hematopoietic Stem Cell Transplantation. Science Translational Medicine, 4(124):124-28, DOI: 10.1126/scitranslmed.3003509

Early Surgery for Refractory Epilepsy Improves Quality of Life

Patients with drug-resistant temporal lobe epilepsy may benefit from surgical intervention soon after failure of two antiepileptic drug (AED) trials, according to results of the Early Randomized Surgical Epilepsy Trial (ERSET).

Surgery is usually seen as a last resort, but researchers have concluded that earlier intervention could help epilepsy patients avoid decades of disability. The findings suggest that operating on patients in such circumstance is more effective in controlling seizures and improving quality of life than continued medical management of the condition.

"Despite reported success, surgery for pharmacoresistant seizures is often seen as a last resort…Patients are typically referred for surgery after 20 years of seizures, often too late to avoid significant disability and premature death," report the research team.

Dr. Jerome Engel Jr. of David Geffen School of Medicine, University of California, Los Angeles led the team which released the report on March 7 in the Journal of the American Medical Association. ERSET was a controlled, parallel-group clinical trial performed at 16 epilepsy surgery centres in the United States. It included 18 males and 20 females aged 12 years and older with mesial temporal lobe epilepsy (MTLE) and disabling seizures for no more than two consecutive years after adequate trials of two AEDs.

The results of this study support the conclusions of the American Academy of Neurology practice parameter, namely that all patients with epilepsy should be referred to an epilepsy centre as soon as trials of two AEDs fail, and surgery should be performed if patients meet criteria for an anteromesial temporal resection (AMTR), note the authors. The research was supported by the National Institutes of Health.

www.medscape.com

Journal Reference:

Englel J et al. (2012). Early Surgical Therapy for Drug-Resistant Temporal Lobe Epilepsy. JAMA, 307(9):922-930. DOI: 10.1001/jama.2012.220

MANAGEMENT NEWS

Shortage of ICU Beds Leads to Patient Deaths

A lacking supply of ICU beds is leading to preventable deaths, according to a study from France.

Dr. Rene Robert of Hopital Jean Bernard in Poitiers, France and colleagues found that out of 1,332 patients referred to ICUs in those hospitals over a three-month period, almost 15% were turned away, at least temporarily, because there were no beds available. They also concluded that those patients that got turned away often had a higher risk of dying than patients who got into the ICU right away.

Overall, 33% of patients who got turned away died within the next 60 days, versus 27% of patients admitted to the ICU immediately. Part of the problem is that there is also a shortage of regular ward beds in many hospitals, suggested the scientists.

The solution to the problem is not simple, but increased compliance with triage guidelines may help, especially when ICUs are full, said Dr. René Robert and his team.

www.medscape.com

Journal Reference:

Robert R et al. (2012). Refusal of ICU Admission Due to a Full Unit: Impact on Mortality. Am. J. Respir. Crit. Care Med. DOI: 10.1164/rccm.201104-0729OC

Thermo SCIENTIFIC

advancing sepsis management

Early identification of sepsis is crucial to improving patient outcomes. Yet sepsis can be difficult to differentiate from nonbacterial infections. Procalcitonin (PCT) is a biomarker that exhibits a rapid, clinically significant response to severe bacterial infection. In patients with sepsis, PCT levels increase in correlation to the severity of the infection. Adding the PCT biomarker assay can help improve the accuracy of risk assessment in sepsis[1] and guide therapeutic decisions.[2,3]

Visit us at ISICEM booth n° 2.47–2.48

Procalcitonin (PCT)

• For more information visit us at thermoscientific.com/procalcitonin

IMPROVING HANDOVERS BY LEARNING FROM SCUDERIA FERRARI

Ken Catchpole, *PhD*

Director
Surgical Safety and Human Factors Research
Cedars-Sinai Medical Centre
Los Angeles, USA

Ken.catchpole@safersurgery.co.uk

Introduction

It has been nearly a decade since seminal reports and associated research documenting the surprising frequency of accidental injury in healthcare were published in the UK and around the world (Vincent, Neale and Woloshynowych 2001). Around that time, complex and systemic causes of a sequence of probable accidental deaths at the Bristol Royal Infirmary were emerging, while research at Great Ormond Street Hospital was finding that small, seemingly innocuous events could accumulate to affect mortality and morbidity (de Leval et al. 2000). In these incidents, the technical challenges of complex surgery in very high risk patients meant that teams were sometimes unable to prevent errors that subsequently affected patients.

All complex systems are faced with the same problem: although humans are fallible and make mistakes, they cannot be designed out. This is not just because humans design, maintain, operate and promulgate technology, tools and tasks that allow regular systems function, but also because they keep all these disparate components together. Complex systems themselves are naturally unsafe. It is the people and teams within them that allow them to achieve high standards (Dekker 2002).

It is with this in mind that there has been much speculation on how to learn from other industries to address safety issues. We at Great Ormond Street Hospital were able to learn from the Ferrari F1 team, which comprises a complex system, and apply this knowledge to improving a critical handover process, thus developing new ways to think about safety in high risk surgical care.

High Risk Handovers

Providing continuity of care between frequently changing teams is an area of vulnerability in any complex system. With the increasing transfer of patients between clinical areas, and the reduction in working hours following the European Working Time Directive, continuity of care has vastly increased in importance in the clinical field. The transfer from the operating theatre to the intensive care unit is one of the most difficult stages in the care of a child, concluded Kennedy (2001). These children, often only days old and having had a hugely invasive surgical operation, can be extremely unstable and will require support from a wide number of inotropes, vasoactive agents, other drugs and several invasive monitoring lines. They need to be moved from safe ventilation and monitoring to portable equipment while they are transported a short distance into the ICU (in Great Ormond Street Hospital this was only 30 or 40 meters). Here they are returned to safe monitoring and ventilation. Bed space is configured around these patients, with infusion pumps placed on a stand and plugged into the power socket, and monitoring lines plugged into the monitors, which are then appropriately zeroed. During the same period, the surgeon and anaesthetist hand over to the receiving doctors and nurses in the ICU the vital information required for the care of the patient, which they have gathered during pre-operative assessments and several hours of surgery. At this point, the ICU staff may have little knowledge of the patient.

Thus, there are two critical safety tasks that occur at the same time: the transfer of the monitoring and life support equipment, and the transfer of information. Our early observations suggested that things did not always go smoothly in this risky stage of operations. Sometimes the patient was on portable monitoring and support equipment longer than they needed to be because either the teams did not know which bed space was being used; the bed space was not prepared; the correct monitoring lines or data interfaces were not immediately available; or the ICU ventilator needed configuration before the patient could be safely put onto it. Sometimes the infusion and monitoring lines were cluttered or tangled, and sometimes the infusion pumps were not plugged in and eventually ran out of battery power. Also, the receiving ICU staff may not have been aware of a patient's imminent arrival so they were not always immediately available. Another important issue was that sometimes the verbal handover was con-

> *"The transfer from the operating theatre to the intensive care unit is one of the most difficult stages in the care of a child" (Kennedy 2001)*

ducted at the same time as the equipment was set up, thus stretching human cognitive resources and inviting information degradation. At other times, the full set of information was not handed over.

Though it is possible to argue that these small problems were not affecting patient care, our research (Catchpole et al. 2006), and the work of others in the growing field of patient safety, was starting to suggest that the small things really do matter. The high risk of handovers was identified in the Bristol Royal Infirmary enquiry, while previous research at Great Ormond Street Hospital found problems in handovers, with several recent events and near misses identified to be partly attributable to this poor performance. We felt that these risks could relatively easily be reduced by small process changes, but we needed to understand how.

Learning from Other Industries

High risk industries usually manage to function effectively and to a high degree of safety in extremely adverse environments, with a huge literature covering the field. Nevertheless, serious accidents can be found in all these industries: Piper Alpha (Oil), Chernobyl and Three Mile Island (Nuclear), Challenger and Columbia (Space exploration), Tenerife and Kegworth (Aviation), Aryton Senna (Formula 1). The key is that in all areas, it is possible and necessary to learn from past tragedies. Rather than blame individuals, we need to understand how teams came to make the critical mistakes that they did, and build better systems of work around people to encourage the avoidance, identification and mitigation of errors before they can lead to more serious consequences.

Indeed, the notion that is conveyed through these industrial analogies is that the optimisation of human performance at the centre of every system can be approached through the application of science to the design of technology, the working environment, tasks, training, and even organisations. This approach is known as human factors, and it has helped make high- and low-risk industrial processes, and a wide range of consumer products, including cell phones, software, and even toothbrushes, more reliable, easier to operate, and safer to use. The key to learning from other industries is in translating their positive principles to the new context.

While researching ICU handovers, intensive care specialists Allan Goldman and Nick Pigott, and surgeon Martin Elliott, recognised through their shared interest in motor racing that a handover might have similarities to a pit stop. Just like a handover, a pit-stop requires a team of specialists to co-ordinate and work together under time pressure, to perform a complex technical task to a high degree of accuracy, in a changing and rapidly evolving situation. Given how reliable pit stops are, and how unreliable our handover processes at Great Ormond Street Hospital had been observed to be, they theorised that it might be possible to improve our work by learning from Formula 1.

Learning from Ferrari

I, Dr. Ken Catchpole, author of this article, joined the project team, and the two ICU doctors and I were invited to the Ferrari headquarters in Maranello, Italy to discuss pit stops with the race technical director. We showed him a video of our process and discussed at great length how Ferrari achieved the performance levels in pit stops that we sought. Upon return to the UK, we were also able to obtain the views of two British Airways pilots on approaches to structuring teamwork and communications.

Earlier, a Failure Modes and Effects Analysis had been conducted to understand where the biggest risks in the process might lie. After deliberating at some length over the lessons learned and how we might translate them into the highly technical tasks of ICU handovers (Table 1), we eventually derived a process that included the entire range of elements that we had learned (Figure 1).

The New Handover Process

The new handover was a four stage process. First, we asked the anaesthetist to fill in a standard form that detailed the ventilator settings and bed space configuration that would be required for the patient upon arrival in the ICU. They would contact the ICU approximately 30 minutes before the patient was due to be transferred so that the receiving nurse could collect this form from theatre. This meant that the bed space, ventilation and all required monitoring interfaces could be prepared beforehand, minimising the time that the patient was off stable monitoring and ventilation. It also meant that the receiving ICU team knew exactly when to expect the patient.

Upon arrival in the ICU, the equipment was set up without any verbal handover. Each team member had been assigned a specific role, so everyone knew exactly what should be happening. The lead anaesthetist then made a safety check to ensure that all the monitoring was reading as expected, the ventilation was appropriately configured, and the infusion lines were untangled.

The third stage of the process was the verbal handover, which was given a specific order and rhythm. The outgoing surgical team and the receiving ICU team all grouped at the patient's bed to listen to the anaesthetist, followed by the surgeon, provide information. The entire team was then provided the opportunity to pose questions and discuss the situation. The receiving doctor used an information transfer aide memoire, a form or checklist specifically designed for this process, to prompt and record the transfer of the appropriate information. Once all the blanks on the form were filled (or discussed where missing), the form was placed in the patient's notes and acted as the admission note to the ICU, saving everyone time.

At this point, transfer of responsibility of the patient to the ICU team was complete, so in the fourth stage, the team (still including the surgery team) discussed the expectations for this patient. These were grouped into one of four categories of risk and further treatment, from immediate waking and extubation through six-hour and overnight reviews, to the expectation of high risk for extracorporeal membrane oxygenation (ECMO).

Importantly, and in contrast to both aviation and motor racing, the new process could be trained in 20-30 minutes. This is key, given the high turnover of staff and trainee doctors.

Formulating Change

At the time we conducted this work, the idea that the way change is made can be as important as the change itself was not as widely acknowledged as it has now become in patient safety (McGrath et al. 2008). We certainly encountered resistance from some doctors and nurses who failed to see the relevance of learning from other industries, or the need to change existing practice. Nevertheless, we were able to quickly introduce the new protocol, in part because it reflected a number of successful elements that are now more widely understood to be important for establishing new working methods. These included:

- **Recognition of the need for improvement.** The burning platform of the handover process was recognised following a number of incidents within the unit, as well as substantial prior research evidence. Overall, several anaesthetists were unhappy with the previous process, as handing over high risk patients without being assured of reliability made it difficult to trust receiving doctors;
- **Inspiration for change.** Helping people to step outside their normal working pattern to see how differently things can be done can be a really valuable technique for triggering change. It helped to raise aspirations for something better. The media interest surrounding the project, though clearly not replicable, also helped convince people that the new method was at least worth trying;
- **The benefit of human factors involvement in solution development.** Systems are complex and interacting, so successful change needs to occur and be understood at a variety of levels within the system to provide the opportunity for achieving the goal of behavioural change. Solutions need to be multi-dimensional and human factors science provides a far greater range of solutions than might be achieved through uni-dimensional, analytical or interventional approaches;
- **Direct involvement of senior stakeholders.** Having both the senior intensive care specialists and the most senior surgeon directly involved with the process was essential. During the project, particularly in the change period, we also involved a senior anaesthetist and a senior nurse. All commented on and adapted the process so were able to feel some ownership over it; and
- **The intervention was multi-dimensional.** The nature of the intervention, including checklists, defined processes, teamwork, leadership, and task allocation, meant that if one component was not reliably taken up, the entire process would not fail.

Table 1: Lessons learned from Pit-Stops

Construct	Pit Stop Practice	Principle	Application to Handovers
Process Organisation	A clear rhythm and order to events.	Task Sequence.	Stages in handover clearly defined and delineated.
	All team members have clearly defined tasks and roles.	Task Allocation.	All members have dedicated tasks. Ventilation: anaesthetists; monitoring: ODA; drains: nurses
	Explicit communication strategies to ensure calm and organised atmosphere.	Discipline and composure.	Communication limited during equipment transfer. A specific order for the information handover. No interruptions.
Teamwork	Leader is the 'lollipop man' who has final go/no go decision.	Who is in charge?	Defining a clear leader and a precise moment for transfer of responsibility.
	Extensive meetings at all levels before every race to establish shared situational picture and goals.	Briefings.	A specific phase for information transfer. All team members involved. Structured as communication, then dialogue, then agreement of goals.
	All team members encouraged to contribute ("it's not about having the best people but having people who work together").	Involvement.	All team members involved in the information transfer and recovery discussions. Speaking up encouraged. Opportunities for contributions built into the discussions.
Threat & Error Management	Reliability established in safe cultures through extensive documented reminders.	Checklists.	Ventilator settings transfer sheet. Information transfer aide memoire.
	Anticipation of weaknesses and having contingencies.	Predicting and planning.	Formal FMEA of process. Safety checks built into process. Predicition of future patient needs and likely risks.
	Overview and error capture by most able team member ('lollipop man'). notices; understands; predicts consequences.	Situation Awareness.	Consultants maintain overall picture and awareness by standing back and monitoring rather than being involved in minor tasks.

HAMILTON·C3

Intelligent Ventilation

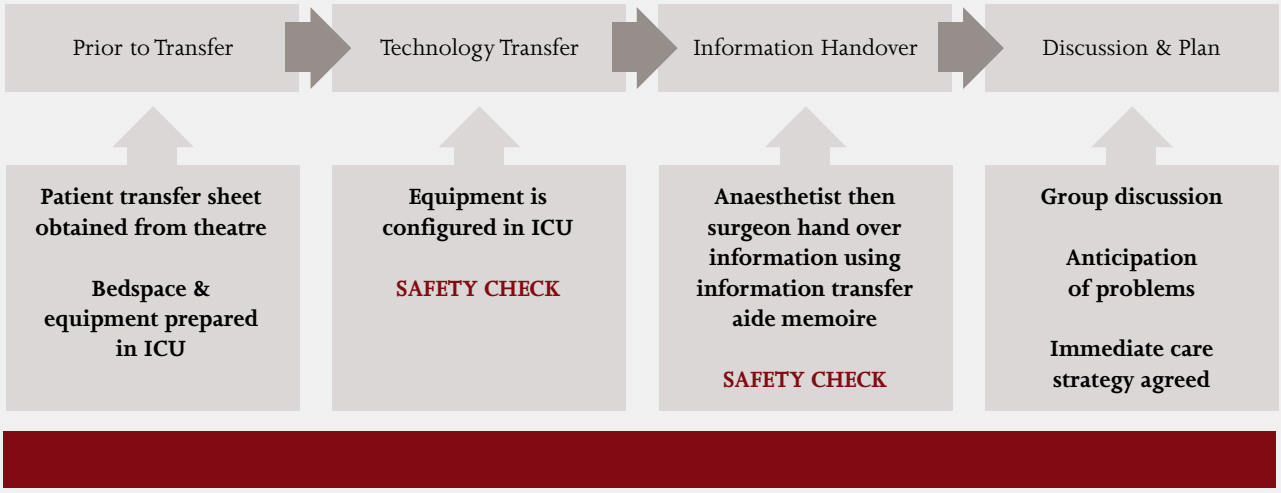
The big picture in Intelligent Ventilation

The new HAMILTON-C3 has been designed to ventilate adult and pediatric patients in the critical care environment. With optional support, the HAMILTON-C3 is also able to ventilate infants and neonates.
The unique Ventilation Cockpit™, with its 12,1" high definition widescreen, provides exactly the information you need and helps you focus on what's important. The Dynamic Lung and the Vent Status window assist you in immediately identifying the patient's lung condition and assessing the weaning process. Adaptive Support Ventilation (ASV) makes ventilation intelligent by providing optimal support at each breath for virtually all patients.
The HAMILTON-C3 with built in batteries and a turbine give you maximum independence and flexibility to accompany your patient everywhere.

HAMILTON MEDICAL AG
Via Crusch 8, CH-7402 Bonaduz, Switzerland
Tel (+41) 81 660 60 10 Fax (+41) 81 660 60 20
www.hamilton-medical.com

HAMILTON MEDICAL

Figure 1: Overview of the new process



Positive Evaluation

Change without evaluation is risky. It is important to know whether the alterations have indeed helped to forge improvements. This can provide more incentive for change to those staff members who are still resistant, reducing the risk of reverting to old, less reliable processes.

Long before visiting Ferrari and developing the new process, we designed a set of observational measures based on process, teamwork and information exchange. A 16-item checklist was used to evaluate the ease of equipment transfer in the handover process, and any deviations from the optimal process were marked down. Meanwhile, teamwork was scored with a five-point anchored likert scale on four dimensions: leadership and teamwork; task management; workspace and equipment management; and situation awareness. At the same time, information transfer was scored on a 17-point scale, assessing whether there had been any omissions. Finally, the duration of each handover was measured to counter criticism that there wasn't sufficient time to conduct the new process.

Twenty three handovers were analysed before the changes were made and 27 were evaluated afterwards, with improvements noted on all dimensions measured. However, the data also revealed more differences between the old and new processes. Beforehand, poor information transfer was correlated with poor equipment transfer, but after the alterations this correlation was almost non-existent. In other words, while the new process was still not always perfect, the errors were less likely to escalate during one handover. Given that it is this 'domino' effect that increases risks to patients, our new process demonstrated the vital improvement sought.

Furthermore, by providing a structure and common way of working, we were able to help those really good teams perform exceptional handovers, while preventing the less effective teams from going too far wrong.

The final confirmation that this had been a success came in other forms. This new way of working was sustained for at least two years, after which personal reports suggested that the anaesthetist had been able to trust the process, and thus the care that the ICU doctors would provide to patients. Moreover, in discussions many months later, anaesthetists were heard to say; "This is great – but we can make it better". That signal of the desire to continually learn and improve was truly the sign of high reliability.

Conclusions

We were able to improve our vulnerable processes by translating good practice found in two industries – aviation and motor racing – into healthcare. We were able to do this by taking into account the subtle complexities of healthcare and developing a solution upon multiple dimensions, rather than a single one, while sensitively involving all the major stakeholders in the implementation of change, and conducting a detailed evaluation to show that it worked. Change in healthcare is not easy, as safety improvements are constantly threatened by organisational and financial pressures to be more efficient; however, accepting things as they are and failing to learn from mistakes is something that should not be excused. Whether that inspiration comes from fast cars or jet aircraft, it is essential for the future of healthcare. ■

References

Catchpole KR, Giddings AE, de Leval, MR et al. (2006). Identification of systems failures in successful paediatric cardiac surgery. Ergonomics, 49(5-6):567-588.

Catchpole K et al. (2007). Patient Handover from Surgery to Intensive Care: Using Formula 1 and Aviation Models to Improve Safety and Quality. Pediatric Anesthesia, 17:470-478.

de Leval MR, Carthey J, Wright DJ, and Reason JT (2000). Human Factors and Cardiac Surgery: A Multicenter Study. Journal of Thoracic and Cardiovascular Surgery, 119(4):661-672.

Dekker SW (2002). The Field Guide to Human Error Investigations. Aldershot: Ashgate.

Kennedy I (2001). Learning from Bristol: the report of the public inquiry into children's heart surgery at the Bristol Royal Infirmary 1984 -1995.

McGrath KM, Bennett DM, Ben-Tovim DI et al. (2008). Implementing and sustaining transformational change in health care: lessons learnt about clinical process redesign. Med.J.Aust, 188(6 Suppl):S32-S35.

Vincent, C., Neale, G., & Woloshynowych, M. (2001). Adverse events in British hospitals: Preliminary retrospective record review. British Medical Journal, 322:517-519.

THE INTENSIVE CARE UNIT OF TOMORROW

A Case Study of Patient-Centred Care

Jozef Kesecioglu, *MD, PhD*

Director and Manager Research and Education
Department of Intensive Care Medicine
University Medical Center Utrecht
Utrecht, the Netherlands

j.kesecioglu@umcutrecht.nl

Margriet M.E. Schneider, *MD, PhD*

Chair and Medical Manager
Department of Internal Medicine and Dermatology
University Medical Center Utrecht
Utrecht, the Netherlands

M.M.E.Schneider@umcutrecht.nl

The University Medical Center Utrecht (UMC Utrecht) is a 1,042 bed hospital, which admits approximately 30,000 inpatients per year. All academic specialties are present and the hospital provides a core service in heart and lung transplantations, ventricular assist devices, trauma, neurosurgery, oncology, haematology and AIDS patients. In 2004, an independent survey measuring the quality of care and effectiveness of intensive care units in the Netherlands concluded that UMC Utrecht performed adequately in this field, a stature which the hospital board subsequently felt could be improved. The first change to be made was in the overall structure of the ICU. Originally, the intensive care department was divided into four separate sectors: internal, surgical, cardio surgical and neurological/neurosurgical units, all of which were located in different parts of the hospital. In the new arrangement, these divisions were re-organised as a multidisciplinary medical department, marking the birth of a revolutionary project headed by the authors of this article.

Introduction

The vision generated by this team was to create an intensive care department that produces the best possible environment for critically ill patients and their relatives, allowing doctors and nursing staff to focus on the patient. Patient-centred care, safety, functionality, innovation and future-proof concepts evolved as the main aspects of the new ICU design. Former patients and their family members were interviewed to assess opinions on the present condition of the department, including its shortcomings, and significant issues to be considered when building the new ICU were identified. Daylight, tranquil surroundings, patient privacy, adequate space, family comfort, ergonomics, logistics and safety were communicated as important, and concepts for improvements in these areas were developed. Two courses were implemented, with the first centred on architecture and interior design dictated by patient-centred care, and the second focused on functionality, safety and innovation.

Patient-Centred Care

In designing patient rooms, the well-being and orientation of the patient were considered of main concern; therefore, a key focus was the formation of a day and night rhythm. Each of the 36 single-patient rooms measure 25m^2 and have a view either to either one of the four specially designed 60m^2 Dutch gardens or to other well lit spaces, providing sufficient daylight to the department.

> *"An organisation structured around the needs of the patient is mandatory in designing an effective intensive care department"*

The rooms are also designed to make patients feel at home, featuring comfortable armchairs and fashionable lamps among other attributes, all coordinated with soft warm colours. A whiteboard with the names of attending personnel was placed inside each room to forge a more personable atmosphere as well as to provide another method for sharing information, while a clear glass wall and door separates the room from the nursing staff, replacing what were old-fashioned curtains. The glass doors close automatically, unless kept deliberately open, providing a quiet environment for the patient. Also, since the glass is electrostatic, meaning it instantly becomes opaque at the touch of a button, privacy is guaranteed whenever required.

The ceiling of each room is painted in a soft blue with as few irregularities as possible, increasing the relaxing tone of patients' surroundings in the hope of lessening feelings of disorientation by patients suffering from delirium, a frequent occurrence in ICUs. Such patients commonly imagine strange phenomena emerging from the ceiling whereas in fact it may simply be an air conditioning duct. Simple aspects such as this are often overseen but can make a significant difference in patient comfort levels.

The Needs of the Patient's Family

The benefits that could be generated for visiting relatives were not overlooked when forming the new ICU scheme, including from the perspective of the positive effects they have on the patient. It was recognised that comfort and peace of mind have a significant effect on the overall atmosphere. A large area with catering and Internet facilities is reserved for family use, while a 24-hour visiting policy is applied, with no restrictions on visiting time.

With family values in mind, six double bedrooms, each with a bathroom and shower, were built in the unit for those relatives who live far away, or for specific cases where the patient is particularly ill. From the provision of PCs with Internet connection, cable TV and telephones, to outside meeting space and their own cafeteria, relatives are made to feel as welcome and as comfortable as possible. The family area is situated in a quiet corner of the floor so that members are not exposed to the daily activities of the intensive care department, giving them an atmosphere of privacy, security and trust.

Functionality, Safety and Innovation

Before buying any required medical equipment, concepts were developed concerning functionality, safety and innovation, with these set to shape subsequent choices on medical apparatus. The main themes considered when making decisions were the availability of a physician and nurse at the patient's bedside or nearby throughout their stay, ergonomics, safety and silence.

Physician and Nurse at the Bedside or Nearby

Simplicity, ease of use and minimal alarms were all features high on the list with regard to selection of medical equipment. The chosen system with remote control use of monitors from outside patients' rooms resulted in fewer interactions; however, an innovative solution was found. As the patient rooms were divided in pairs (36 beds in all) with a small nurse station outside each pair, the monitor at each desk allowed the staff to do exactly what was required: view, control, review and record, all from outside the patient's room. With these measures, the patients are not exposed to unnecessary noise and presence of personnel in the room.

In the old setting, when patients ware stable it was common for nurses to gather behind the central post to observe them, whereas physicians would be documenting patients in a room allocated for this purpose. In the new concept, there is a desk with computer seats and monitors outside each patient room, allowing visual access to all patients. Computers are connected to the hospital and intensive care patient data management systems (PDMS), as well as hospital and worldwide Internet. Via this new setting, nurses can observe their patients outside their rooms in between patient care, and physicians are able to go to the desks after examining patients to confer with nurses and other colleagues.

One of the new workstations allowing VCRR (view, control, review and record) from outside the patient's room.

Ergonomics

Patient rooms have ceiling service units for the medical apparatus and PDMS, allowing for convenience and comfort. The routinely used medical equipment is off the floor, and flexible positioning of a patient's bed is possible. The bed can be positioned easily towards the gardens or the outside view without extensive re-positioning of the other equipment.

Safety

Each nurse carries a bleeper which receives specified patient alarms; the device can also be used to call for help in emergency situations. Medications and supplies are prepared and delivered to patients by the pharmacy personnel and logistics department, with most medicines prepared and delivered ready to use in syringes. The pharmacy located within the ICU prepares more than 80% of the medicines used by its patients, reducing errors significantly.

In another section of the department, infection control rooms were fitted with a double door positive pressure system, with a sophisticated delivery system for supplies, to reduce the risk of cross infection.

The Sound of Silence

The new intensive care department, especially the patient rooms, has carefully been provided with a quiet and peaceful atmosphere. This can be summarised with new unit and concept design, spreading the medical and nursing personnel evenly across the floor instead of gathering them at the central post, and keeping the doors of the rooms mostly closed. An ongoing project aims to improve the alarm systems, filtering the alarms to be sent selectively to the cell phones of the nurses, and avoiding alarms within patients' rooms.

Conclusion

An organisation structured around the needs of the patient is mandatory in designing an effective intensive care department. Materials, apparatus and buildings will eventually get old, but the concepts such as daylight, privacy and safety will always be the future. Concepts should, however, be developed and used in choosing medical equipment so that the entire scheme developed will survive the test of time.

As a result of these innovative developments, UMC Utrecht was selected as the recipient of the 2011 ICU Design Citation Award, which is co-sponsored by the Society of Critical Care Medicine, the American Association of Critical Care Nurses and the American Institute of Architects Academy on Architecture for Health. ■

NEW AMBULANCE CONCEPTS TO IMPROVE CARE IN THE ICU?

Ed Matthews

Senior Research Fellow
Health & Patient Safety Research Lab
Helen Hamlyn Centre for Design
Royal College of Art
London, UK

ed.matthews@rca.ac.uk

Gianpaolo Fusari

Research Associate
Health & Patient Safety Research Lab
Helen Hamlyn Centre for Design
Royal College of Art
London, UK

The Helen Hamlyn Centre for Design at the Royal College of Art in London has a focus on people-centred and inclusive design. From its origins, researching and designing for an ageing population, its work has grown over the past 20 years to encompass better healthcare and better workplaces, because many people now live and work longer despite age-related changes in their abilities. To focus on these increasingly important matters, the centre has developed three research labs: the Age & Ability Lab, the Work & City Lab and the Health & Patient Safety Lab.

Introduction

The Health & Patient Safety Lab has made a significant impact through research and design projects, having reduced medical errors through better infection control; better labelling and packaging of medication; improved infusion pump interfaces; better surgical instruments; and safer and more effective resuscitation trolleys and neck immobilisation collars. It has also designed products with patients' self-esteem in mind, and used design to reduce violence and aggression in accident and emergency (A&E) departments.

This article focuses on Helen Hamlyn Centre for Design's work on ambulance design since 2005. It is relevant here because there are many similarities with ICU design, and the same methodology could probably deliver worthwhile improvements in ICU settings. The UK's ambulances are sometimes referred to as A&E vehicles, because that is almost always their field of application; however, from time to time they serve temporarily as the nearest thing to the ICU for critically unwell patients.

The ambulance dates back to horse-carts used in the Crimean War to transport wounded soldiers back from the battle line, and they have only developed incrementally since then. Clinical science has meanwhile progressed, and the need to design a treatment space fit for purpose within that clinical reach is long overdue. This paper considers whether the ICU has also developed only incrementally while clinical science and available technology has progressed, and would also benefit from a fresh design approach.

Project History: Innovative Ambulance Design

In 2005 we at Helen Hamlyn Centre for Design studied adverse incidents in ambulances for the UK National Patient Safety Agency, which had gathered incident reports indicating a significant sense of unease with regard to ambulance design. We quantified and analysed the data and identified ten design areas that could be improved with a better design. This work fed into the ongoing ambulance standardisation programme in the UK, as well as into a proposal to the UK Engineering & Physical Sciences Research Council to fund the Smart Pods project, which looks at opportunities to develop an integrated system of mobile healthcare, involving more treatment in the community, using the skills of more highly trained paramedics. Existing research at the time showed that about 60% of 999 calls in the UK did not require admission to hospital, and could be better and more cost-effectively treated or managed externally.

By 2009, the Smart Pods research project successfully outlined an integrated pre-hospital healthcare system – a combination of improved emergency ambulances, small responder vehicles, mobile kiosks, standardised treatment spaces, consumables packs and equipment – brought together under an operations management umbrella. In the absence of resources to do everything in parallel, a project to improve the conventional ambulance treatment space that could potentially be developed with limited funding, offered a finite package. Redesigning the ambulance treatment space was considered a key element of the whole system, since ultimately there needs to be a means of treating, stabilising and transporting those patients who need to go to hospital.

Methodology for People-Centred Design

Since the Helen Hamlyn Centre for Design was set up in 1991, we have brought designers and users together to analyse user needs and to develop and agree on an evidence-based design brief. The term users in this case refers to clinicians; patients; crews who maintain, clean and stock the vehicles; fleet managers; procurement teams; health service officials; and others who have a responsibility for the ambulance over its life. The next step is to create a mock up of the design, and to build test rigs to evaluate them. The findings of the evaluation feed back into the research, and the process is reiterated until the solution is robust enough to be physically prototyped and validated.

The process for developing the new ambu-

lance interior was research led from its inception and is an example of co-design, where our role was to facilitate collaboration among the broad spectrum of ambulance users described above throughout the project's development. Adopting a co-design process had two main advantages: firstly, it ensured that the stated and unstated needs of the users were met as far as practicable, and secondly, it encouraged the different stakeholders in the project to engage, own and accept some design compromises.

The initial objectives set for the redesigned ambulance aimed to improve patient safety, enhance clinical functionality and reduce costs for the NHS. We employed a multidisciplinary approach, partnering with university and hospital-based emergency care specialists, ambulance service managers, front-line paramedics and crews, as well as engineers and industrial designers, and went through three reiterative design cycles, each consisting of four stages: learn, design, evaluate and analyse.

Research began by accompanying ambulance crews on 12-hour shifts in order to document, observe and understand the complexity of their work at first-hand. These rich experiences, paired with having an advanced paramedic on the project team from day one, accelerated the flow of ideas and the gathering of insights.

In parallel to our empirical observations, a 1:1 cardboard representation of the current ambulance was developed in our purpose-built ambulance research lab where we invited clinicians to talk about and demonstrate some of the current practices carried out in ambulances. Typical ambulance modes of use were then mapped to understand the needs and limitations that crews and patients face every day, and a thorough audit of current ambulance equipment and consumables was completed. We then correlated the equipment and consumables data with the identified modes of use to come to decisions that utilised the minimum amount of space in light of requirements.

This gave us a solid base to begin exploring ideas through sketches and rough cardboard models. Paramedics were invited to the ambulance lab to discuss and critique the rough proposals and aid in the refinement and development of the ideas. Eventually the rough ideas became 3D computer data, which were soon transformed into full-size test rigs constructed in wood, cardboard and foam. Again, paramedics and patients were invited to evaluate and help to expand some of the concepts.

Once an ergonomic layout was agreed upon a more robust test rig was produced along a 1:1 appearance model. Teams of paramedics and patients were invited to perform outlined clinical scenarios on the testing rig, as well as thematic evaluations on the appearance model and DDC system. In addition, a virtual immersion model developed in a stereoscopic simulation space at the Royal College of Art was used to review several variations of interior layouts without the need to physically build them.

Data generated from the evaluation process was analysed by an independent team, and the results were fed back to us and translated into

new learning that kick-started the reiterative cycle once again. Proposals and evaluation methods in every recurring cycle became more sophisticated as the project evolved.

The project resulted in a full-size demonstrator unit for all UK ambulance services to assess. This has created a fundamental building block of the new system, as envisaged by the Smart Pods research, and opened the way for further investment that will enable the whole system to be designed. The new treatment space features:

Figure 1: A computer simulation depicting the proposed ambulance's ergonomic and efficient layout

- A centrally positioned stretcher, to allow clinicians 360° access to the patient, facilitating safer, more efficient treatment. A large stretcher is used to manage bigger patients in response to the trend towards increasing obesity;
- All equipment and supplies located on one side of the vehicle on a simple, ergonomically designed 'working wall'. A simple but effective addition is a small foldout table for the attendant to use as a lay-down space for items in use, instead of having to rest them on the patient;
- Modular treatment packs, which are loaded into the vehicle before each shift by the 'make ready' team. This way the crew can be confident that the vehicle is fully stocked for the shift. Among other necessary items, the pack contains dressings, cannulas, an airways and oxygen kit, and a maternity pack;
- A collaboration of technologies that are used daily in our phones and cars. A Digital Diagnostics and Communication (DDC) system unfolded, providing enhanced road navigation, enabling video links and discussion with hospital colleagues and specialists, and providing remote access to patient records. It also sends vital signs and handover information directly to the hospital while en route. This is more efficient and less prone to error than transcribed notes;
- An easy-clean interior, designed to avoid corners and crevices where dirt can collect. The evaluations have demonstrated significant improvements in infection control as a result. The interior is also better lit, has a better ambience and is less intimidating;
- Simple additional features, including hand-cleaning facilities, which, contradictory to patient safety advice, are not currently available. Storage facilities and a cooler box are also provided, with the latter expected to reduce food poisoning among staff, who had reported their sandwiches going off during a 12-hour shift in hot weather.

Evaluations of paramedic performance in the new ambulance design have demonstrated that these features significantly reduce the time taken to complete treatment stages and infections, while improving staff technical skills through better ergonomics, and impacting positively on patient outcomes. Estimated UK-wide cost savings of 35 million pounds could be achieved through reduced emergency department and hospital admissions, with more patient treatment carried out closer to home, a clear patient preference (Darzi, 2008).

This ambulance interior is the result of an evidence-based design brief derived from first principles research, which could be applied to ICU design. The starting point was to consider several issues:

- How to reconfigure and design a standardised treatment space to improve clinical effectiveness and safety for patients and clinicians: The design responds to this concern by providing a logical layout and standardised working environment, which contains all equipment and materials needed during the work shift, with better infection control (see Figure 1).
- How to reduce staff injuries: The design's central stretcher position and seating layout eliminates reaching over the patient to access equipment and consumables;
- How to improve stock control and standardise equipment: Prior to a work shift, the 'make-ready' crew loads all items in required quantities through use of modular packs. UK-wide adoption of the design reduces errors through consistency;
- How to improve patient experience, treatment capabilities, working environment and infection control: A clean, uncluttered, reassuring interior, with better lighting and easier clinician workflow, all improve patient and staff experiences; and
- How to improve diagnostics, communications and data transfer through digital technologies: The DDC unit combines state of the art technologies in a mobile overhead unit, wirelessly linked to a paramedic workstation and the driver's navigation console.

Key Message

Our co-design approach has not only worked for the ambulance, but also in other medical contexts, most notable in advancing the resuscitation trolley and the neck brace. Our questions is this: Could a collaborative approach between people-centred designers and clinicians, using a process of research, co-design and evaluation, and focused on the ICU, lead to a better adapted design, ergonomically laid out to support evolving clinical thinking and improvements in kit and technology, which delivers better patient outcomes? We hope you agree it is a question worth asking. ■

For more information please visit: http://www.hhc.rca.ac.uk/292/all/1/health--patient-safety.aspx

References

Darzi (2008). High Quality Care for All: NHS Next Stage Review final report. Department of Health.

EXCELLENCE IN NUTRITION THERAPY:

Lessons from the International Nutrition Survey and the Best of the Best Awards

Emma Ridley, *MPH*

Nutrition Department
The Alfred Hospital
Australian and New Zealand
Intensive Care Research Centre
Department of Epidemiology and
Preventive Medicine
Monash University
Melbourne, Australia

Andrew Davies, *FCICM*

Australian and New Zealand
Intensive Care Research Centre
Department of Epidemiology and
Preventive Medicine
Monash University
Intensive Care Unit
The Alfred Hospital
Melbourne, Australia

Lauren Murch, *MSc*

Clinical Evaluation Research Unit
Kingston General Hospital
Kingston, Ontario, Canada

Ibolya Nyulasi, *MSc*

Nutrition Department
The Alfred Hospital
Department of Medicine
Monash University
Melbourne, Australia

Audrey Tierney, *PhD*

Nutrition Department
The Alfred Hospital
Melbourne, Australia

Daren Heyland, *MD, MSc*

Clinical Evaluation Research Unit
Kingston General Hospital
Kingston, Ontario
Department of Medicine
Queen's University
Kingston, Ontario, Canada

dkh2@queensu.ca

Over recent years, nutrition therapy for critically ill patients has gained momentum as an essential part of patient care. Research into this often undervalued intervention has escalated, demonstrating that providing the right amount of nutrition in general, and of specific nutrients in particular disease states, can affect the patient's hospital journey. Recently, several landmark papers on nutrition therapy in the critically ill have caused debate, stimulating further discussion and research (Alberda et al. 2009; Arabi et al. 2011; Casaer et al. 2011, Rice et al. 2011; ARDS Network 2012). An additional focus for future research is to determine the factors that enable (or inhibit) the provision of evidence-based nutrition therapy in the ICU.

Introduction

Since 2007, the Critical Care Nutrition team in Canada, led by Professor Daren Heyland, has co-ordinated the International Nutrition Survey (INS), which aims to describe and improve the provision of nutrition therapy to critically ill patients. The value of participation in this survey by ICUs includes receipt of an individual site report, comparing its practice patterns to the Canadian guidelines and to other participating sites. This benchmarking opportunity enables units to understand their strengths, weaknesses, and opportunities, and to locate where improvements in nutrition therapy can be made. Since its inception, the INS has observed that some ICUs are clearly able to achieve higher degrees of compliance with clinical practice guidelines than other sites (Cahill et al. 2010).

The variability that exists allows us to understand what the top performing ICUs do, and by sharing their trade secrets, lower performing ICUs can be assisted to improve the nutrition therapy they provide and ultimately their patient outcomes (Heyland et al. 2010).

Recognition and Reward: Lessons for Healthcare from the Business Sector

Recognition and reward have long been used to improve performance in business. By highlighting high achievers, others are encouraged to mirror or continue the same behaviour (Bickingham and Coffman 1999). Such a strategy is not regularly exercised to improve healthcare quality; however, the Canadian group postulated that by using a similar strategy, the level of nutrition therapy could be improved. As a result, the Best of the Best (BOB) award was developed and has subsequently been awarded in 2008, 2009 and 2011.

Table 1. Criteria used to identify best practice in nutrition for BOB award. From Heyland et al. 2010.

Determinant	Weighting
Overall adequancy of EN plus appropriate PN	10
% patients receiving EN	5
% patients with EN initiated within 48 hours	3
% patients with HGRV receiving promotility drugs	1
% patients with HGRV receiving small bowel tubes	1
% patients glucose measurements greater than 10 mmol/L (excluding day 1; fewest is best)	3

EN, enteral nutrition; PN, paranteral nutrition; HGRV, high gastric residual volume.

Methods and Metrics

To be considered for the BOB award, participating ICUs must:

- Have a feeding protocol;
- Finalise complete data collection on at least 20 patients; and
- Be willing to comply with data verification.

The criteria for the BOB award were developed in consultation with the Canadian Clinical Practice Guidelines Committee. The scoring criteria can be seen in Table 1. Adequacy of energy delivery is the most important criterion and is based on the delivery of enteral nutrition (EN) and appropriately-prescribed parenteral nutrition (PN) as a proportion of the overall energy prescription. In addition, glycaemic control is included in the scoring system to determine the rate of hyperglycaemic episodes (fewest is best). The remaining metrics relate to internationally recognised strategies that improve delivery of nutrition, such as introducing EN early, using promotility drugs and placing small bowel tubes where appropriate.

Overall BOB scores are achieved by ranking eligible sites against each of the five determinants. The top performing site achieves a score of 'n' points (n = number of participating sites), the second site achieves n-1 and so on. Each of these scores are multiplied by the weighting points and the total points summed up to determine the overall BOB award rankings.

Factors Associated with a Higher Ranking

In the 2008 BOB analysis, multiple linear regression was used to determine which hospital and ICU characteristics were positively associated with a higher BOB ranking. ICU management in a closed structure (compared to an open ICU structure), presence of a dedicated ICU dietitian and the geographic region of the ICU were all determined to be associated with a higher BOB ranking. When these associations were adjusted in a multivariable analysis, the independent predictors of a higher ranking were: being in Canada compared to China or the United States (BOB ranking 30.4 places worse if ICU from China and the United States compared to Canada) and the presence of an ICU dietitian (BOB ranking 23.5 higher if there was a dietitian in the ICU (p=0.005).

Emma and Andrew (The Alfred Hospital) receive the BOB 2009 award from Prof. Heyland

Learning Opportunities

The Alfred Hospital in Melbourne, Australia has been awarded the BOB award twice: jointly in 2009 and solely in 2011. The data obtained from the INS have played an integral part in the quality improvement process at the hospital. It was observed from the 2008 data that 53% of patients commenced EN within 24 hours of ICU admission and 47% of patients commenced after 24 hours. Commencement of nutrition therapy within 24 hours of ICU admission is a key performance indicator (KPI) for the nutrition department; hence, this data highlighted an area for improvement. At this time The Alfred Hospital did not allow EN to commence prior to dietitian review (either in person or on the phone) and this was a recognised source of delay. Access to standard EN solutions for commencement without prospective dietitian approval was instigated. In the subsequent surveys an improvement was observed in the promptness of feeding: 72% and 80% of patients commenced EN within 24 hours in 2009 and 2011 respectively.

A Story of Success

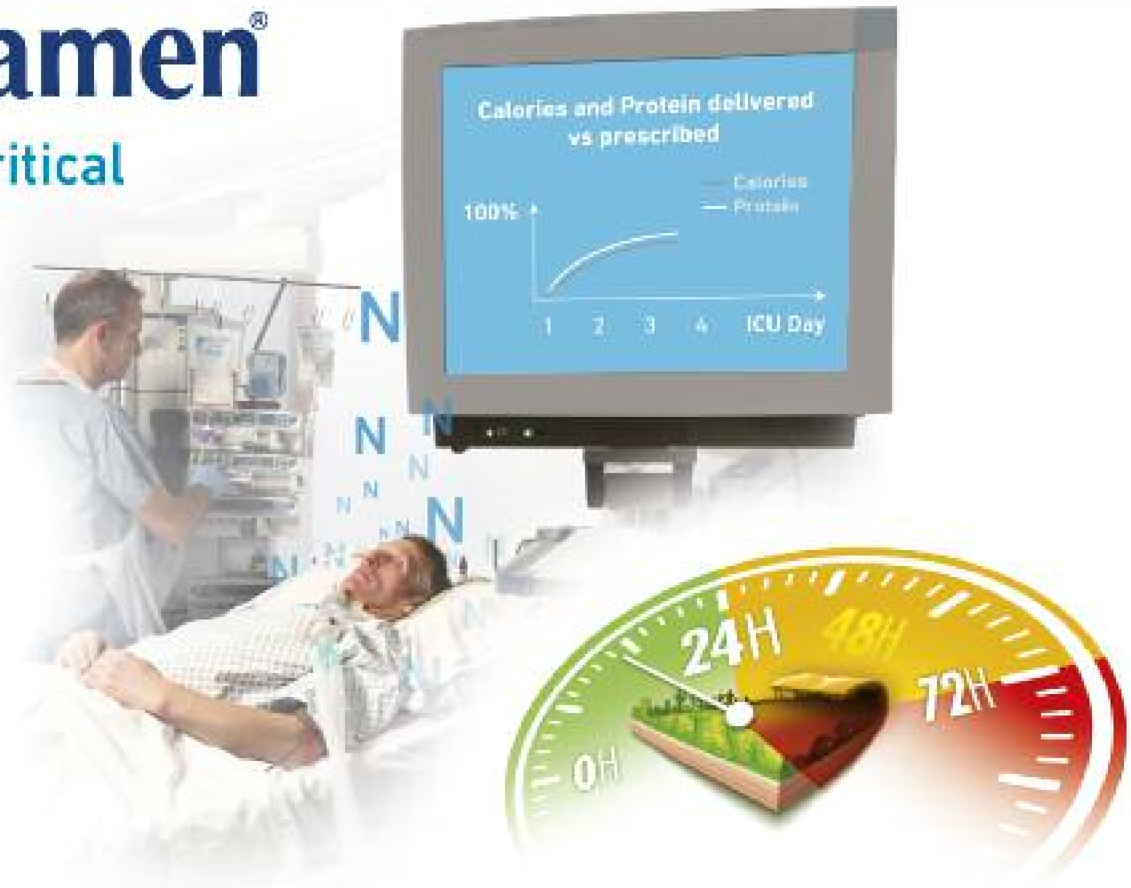
Contributing factors to the achievement at The Alfred Hospital that other healthcare providers may find useful include:

- **Dedicated ICU dietitians:** This is a key element of success. The Alfred Hospital's ICU has 37 beds divided into three service areas. There are 1.1 full-time equivalent dietitians (0.3 per 10 beds), with services allocated to three dietitians. Provision of consistent and well regarded staff in the ICU is also a key feature of this success.
- **Strong leadership**, with a focus on excellence, from both the Director of ICU and the Manager of Nutrition, including dietetic resource allocation.
- **Attendance of the dietitian on the daily ward round**: The dietitian can thus advocate for nutrition therapy and ensure that nutrition is seen as a clinical priority.
- **Clinical practice is guided by an evidence-based feeding protocol.**
- **A KPI relating to the provision of therapy to patients in the ICU within 24 hours of admission** is part of the nutrition department's quality business improvement plan, which is regularly audited.
- **A dietitian is in attendance in the ICU seven days a week**, and when the dietitian is not present in the hospital an on-call facility is in place until 8pm daily.
- **Good working relationships and communication channels** have been developed between medical, nursing and nutrition staff, regardless of seniority.
- **Regular quality and audit processes** occur with timely feedback (including internal projects and audits, and external projects such as the INS).

We believe in the power of nutrition. We call it the **N FACTOR**

Peptamen®

Time is Critical



Peptamen® is a range of enteral nutrition solutions for early and adequate feeding of critically ill patients

Peptamen® AF: Advanced Formula

Designed for better tolerance

- Whey protein to facilitate gastric emptying and reduce reflux[1,2,3]
- MCT* to decrease potential for fat malabsorption[4]
- Peptides to help manage diarrhoea[5,6]

ω-3 fatty acids to help manage inflammation[7,8]

Hypercaloric and high protein to help maintain lean body mass[5]

*Medium Chain Triglycerides

Nutrition. The factor that can make a difference

NestléHealthScience
NOURISHING PERSONAL HEALTH

- **There is access to standard EN and PN solutions** for commencement of nutrition therapy after standard office hours.
- **There is a culture of research and best practice** in nutrition therapy in the ICU and the nutrition department.
- **Nutrition therapy is appreciated in the ICU** and it is embedded into the organisational culture.
- **There is regular participation in formal and informal teaching processes** by medical and nursing staff, and hosting of an external conference on ICU nutrition to share successes and facilitate best practice for others.
- **Constant system improvement:** A computerised data system has been developed to capture real-time data and allow analysis of outcomes associated with nutrition therapy.

Barriers to Change

Unfortunately, the delivery of nutrition therapy does not always amount to best practice in all ICUs, despite the efforts and intentions of those involved. Barriers to change in the hospital setting are well documented, and the area of nutrition offers no exception, but surveys such as the INS can assist in identifying areas for change. In conjunction with the Critical Care Nutrition group, Cahill has led the movement to identify why best practice nutrition therapy guidelines are not adhered to in the ICU. Cahill and Heyland discussed these difficulties in several papers and were able to identify that adherence to guidelines is a response to multiple factors that act as barriers or enablers (Cahill and Heyland 2010; Cahill et al. 2010). From this work it would seem that a tailored approach to implementation of best practice guidelines rather than a 'one size fits all' approach is more effective (Cahill et al. 2010). This, however, requires identification of the barriers, which can be very difficult. To help address this, a barriers assessment was added to the 2011 International Nutrition Survey. This element will assist sites to understand the barriers and enablers to provision of nutrition therapy that are specific to them.

Nutrition as a Measure of Quality in ICU

Quality measures in critical care are recognised as important in ensuring patient safety and optimal clinical outcomes. Markers of quality healthcare in critical care have long been established and include the use of stress ulcer and deep vein thrombosis prophylaxis, central venous catheterisation care and management of blood glucose levels (Pronovost et al. 2001). Measurement of the time until EN commences readily lends itself to being another key marker of quality ICU management. Data such as that collected in the INS can assist with monitoring and benchmarking processes. The recent introduction of the BOB award also provides some healthy competition between both ICUs and colleagues, which should ultimately lead to improved patient outcomes by encouraging continued high performance or improved performance in subsequent years.

> *"The recent introduction of the BOB award provides some healthy competition between both ICUs and colleagues, which should ultimately lead to improved patient outcomes"*

Conclusion

Relatively simple but significant data collection strategies such as the INS can serve as vital tools for improvement of healthcare quality in intensive care. They also provide important opportunities to benchmark care internationally, against past performances and within similar geographic regions. The INS and the BOB criteria have provided a unique opportunity to recognise and document best practice in the provision of nutrition therapy, which can now be shared with our colleagues to improve patient care. ■

References

The National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network, 2012. Initial trophic vs full enteral feeding in patients with acute lung injury: the EDEN randomized trial. JAMA; 307(8):795-803.

Alberda C, Gramlich L, Jones N, Jeejeebhoy K, Day AG, Dhaliwal R and Heyland DK, 2009. The relationship between nutritional intake and clinical outcomes in critically ill patients: results of an international multicenter observational study. Intensive Care Med; (35):1728-37.

Arabi YM, Tamim HM, Dhar GS, Al-Dawood A, Al-Sultan M, Sakkijha MH, Kahoul SH and Brits R, 2011. Permissive underfeeding and intensive insulin therapy in critically ill patients: a randomized controlled trial. Am J Clin Nutr; (93):569-77.

Bickingham M, Coffman C, 1999. First Break All the Rules. New York: Simon & Schuster.

Cahill NE, Dhaliwal R, Day AG, Jiang X and Heyland DK, 2010. Nutrition therapy in the critical care setting: what is 'best achievable' practice? An international multicenter observational study. Crit Care Med; (38):395-401.

Cahill NE and Heyland DK, 2010. Bridging the guideline-practice gap in critical care nutrition: a review of guideline implementation studies. JPEN J Parenter Enteral Nutr; (34):653-9.

Cahill NE, Suurdt J, Ouellette-Kuntz H and Heyland DK, 2010. Understanding adherence to guidelines in the intensive care unit: development of a comprehensive framework. JPEN J Parenter Enteral Nutr; (34):616-24.

Casaer MP, Mesotten D, Hermans G, Wouters PJ, Schetz M, Meyfroidt G, Van Cromphaut S, Ingels C, Meersseman P, Muller J, Vlasselaers D, Debaveye Y, Desmet L, Dubois J, Van Assche A, Vanderheyden S, Wilmer A and Van Den Berghe G, 2011. Early versus Late Parenteral Nutrition in Critically Ill Adults. N Engl J Med.

Heyland DK, Heyland RD, Cahill NE, Dhaliwal R, Day AG, Jiang X, Morrison S and Davies AR, 2010. Creating a culture of clinical excellence in critical care nutrition: the 2008 "Best of the Best" award. JPEN J Parenter Enteral Nutr; (34):707-15.

Pronovost P J, Miller M R, Dorman T, Berenholtz SM and Rubin H, 2001. Developing and implementing measures of quality of care in the intensive care unit. Curr Opin Crit Care; (7):297-303.

Rice TW, Wheeler AP, Thompson BT, Deboisblanc BP, Steingrub J and Rock P 2011. Enteral omega-3 fatty acid, gamma-linolenic acid, and antioxidant supplementation in acute lung injury. JAMA; (306):1574-81.

INTENSIVE CARE DIETITIAN: AN IMPORTANT CONTRIBUTOR TO QUALITY OF CARE

Many experts have shown that nutritional therapy improves intensive care unit (ICU) outcomes. In particular, the use of early enteral nutrition (EN), as recommended by ESPEN guidelines (2006), is associated with a reduction in mortality in the sickest patients (Artinian et al. 2006). Paradoxically, enteral feeding is most difficult to perform in the sickest patients, and several studies have revealed very slow progression with this form of feeding (Alberda et al. 2009; Finfer et al. 2009; Casaer et al. 2011). The difficulties encountered are maximal during the first week, putting these patients at high risk of undernutrition (Villet et al. 2005). Indeed, underfeeding is frequent in this population but should not be considered as a matter of fact. Many actions can be undertaken to improve nutrition care management and achieve important clinical improvements. The introduction of a nutrition protocol in the ICU belongs to this process, and integration of dietitians with specific training in the ICU contributes to quality of care improvements.

Ludivine Soguel, *RD*

Nutrition and Dietetics Department
School of Health Professions – Geneva
University of Applied Sciences Western Switzerland
Switzerland

ludivine.soguel@hesge.ch

Mélanie Charrière, *RD*

Service of Adult intensive Care Medicine and Burns Center
Service of Endocrinology, Diabetes and Metabolism
CHUV
Lausanne, Switzerland.

melanie.charriere@chuv.ch

Mette M. Berger, *MD, PhD*

Service of Adult intensive Care Medicine and Burns Center
CHUV
Lausanne, Switzerland

mette.berger@chuv.ch

Improving Nutrition Therapy in the Critically Ill

Even if some data are controversial, the great majority of studies have observed an improvement in the quality of nutrition support provided when a protocol is in place, reflected by:

- Better adaptation of nutrition to patients' needs (Heyland et al. 2004; Soguel et al. 2012);
- Higher rate of nutrition support (Doig et al. 2008; Soguel et al. 2012) or enteral nutrition (Barr et al. 2004);
- More early applications of enteral feeding and days on nutrition (Doig et al. 2008).

Findings with regard to the impact of feeding protocols on clinical evolution have been positive or neutral, with some studies reporting a beneficial impact on organ function (Doig et al. 2008), length of mechanical ventilation and ICU mortality (Barr et al. 2004), though no impact on length of ICU and hospital stay has been indicated (Barr et al. 2004; Doig et al. 2008; Longchamp et al. 2007).

Soguel et al. (2012) suggested that the positive impact of the protocol will be reinforced by the integration of a dietitian in the ICU team. Indeed, the presence or absence of a dietitian may even explain the different results between studies measuring the impact of a nutrition protocol implementation. To implement a protocol is challenging: when it is poorly practice integrated, it has limited effects (Longchamp et al. 2007; Soguel et al. 2012). The ICU dietitian will act as a facilitator by adapting guidelines to local practice, teaching staff, functioning as an opinion leader, and lowering barriers to protocol adherence (Jones et al. 2007).

Integration of a Dietitian in the ICU

Nowadays, ICU teams are multidisciplinary; the complexity of the patients requires manifold competences to improve metabolic therapy. Dietitians will support physicians and nurses in their daily practice and bring specific nutritional knowledge to discussions. They will especially be involved in patients with the most complex pathologies, applying numerous steps of care: nutrition assessment, diagnosis, intervention, monitoring and evaluation (American Dietetic Association 2008). Several actions can be undertaken by ICU dietitians, as indicated in Table 1. They will be involved in improving the overall quality of care through:

- Maintenance of knowledge and consistency in the care process, especially in teaching hospital ICU staff;
- Continuous adaptation of nutrition protocols in light of new evidence;
- Teaching and introducing practical tools; and
- Promotion of nutrition research.

To enable the benefits, clinical dietitians should be integrated into the daily routine of the unit. They will have to work very closely with other members of staff, particularly with those working at the bedside all day long.

Specific ICU Awareness Required by the Dietitian

Besides the specific nutrition competences that are part of dietitians' pre- or post-grade education programmes, time for integration is required to become an efficient dietitian in the intensive care field. The critically ill patient is a highly complex entity, so coming from a dietetics initial education programme, it will take dietitians several weeks to get familiar with the challenges. Recognition of life-saving treatments and optimal intervention times is not easy. Impact of fluid balances, of vasoactive drugs, of sedatives on weight and gut function are very specific, as are those of an intense inflammatory response on all visceral proteins used for nutritional assessment. Every change from normal must be put into perspective, and specific requirements must all be integrated in order to respond with a clinically adapted proposal. Participation in multiple case discussions is crucial to develop these competences.

Economic Aspects

The presence of a dietitian in the ICU is considered as standard in some countries but is not yet generalised. The NHS in the UK made a staffing proposal but this has been poorly followed through, suggested Windle (2007). Salary costs are frequently considered an obstacle to hiring an ICU dietitian; administrators should be made aware that this is a truncated view of reality, forgetting the costs generated by poor nutrition support. The economic aspects of infectious complications prevention are not yet properly addressed. Both under- and over-feeding cause increased infection rates and prolonged mechanical ventilation, generating very high costs: 32,254 US dollars per bloodstream infection (Kim et al. 2011) and 34 thousand US dollars per ventilator associated pneumonia (Zilberberg and Shorr 2011). The prevention of two to three costly bloodstream infections per year (Rubinson et al. 2004), the reduction by two to three days of intubation time, or the prevention of complications associated with the development of fatty liver, would easily pay the salary of the dietitian. Conversely, malnutrition has an important cost in the ICU, including after discharge, possibly resulting in further hospitalisation and rehabilitation, thus further costs.

Table 1. Examples of dietitians' tasks in ICU

Steps of care	Examples of tasks
Assessment	Nutritional status.
	Determination of specific nutritional requirements according to pathology (renal replacement, burns, trauma, etc.).
	Measurement of energy expenditure by indirect calorimetry and interpretation of the result to determine energy target.
	Evaluation of access present or needed for nutrition support (catheter localisation, type of tube, etc.).
Diagnosis	Refeeding syndrome.
	Undernutrition.
	Inadequate energy intake or macronutrients balance.
	Risk of interaction between drugs and parenteral nutrition.
	Micronutrient deficiencies.
Therapy	Suggestion of an appropriate enteral nutrition solution according to the specific situation (renal failure, renal replacement therapy, diarrhoea, severe hypercapnia, etc.).
	Suggestion of the addition of specific nutrients (glutamine, fish oil, etc.) when needed.
	Proposal of adapted access and tubes for enteral or parenteral nutrition.
	Adaptation of meals to patient's requirements and possibilities.
	Enteral tube placement or assistance for the placement.
	Encouraging shift towards enteral after parenteral feeding.
Monitoring and Evaluation	Focus on patient's care safety.
	Evaluation of the impact of a refeeding therapy.
	Adapting energy target to the evolving situation and patient's lean body mass changes.
	Evaluation of enteral and parenteral nutrition metabolic and intestinal tolerance.
	Preventing overfeeding in particular in case of combined enteral and parenteral feeding.
	Regular assessment of bowel function (constipation, diarrhoea, gastric residuals, etc.)

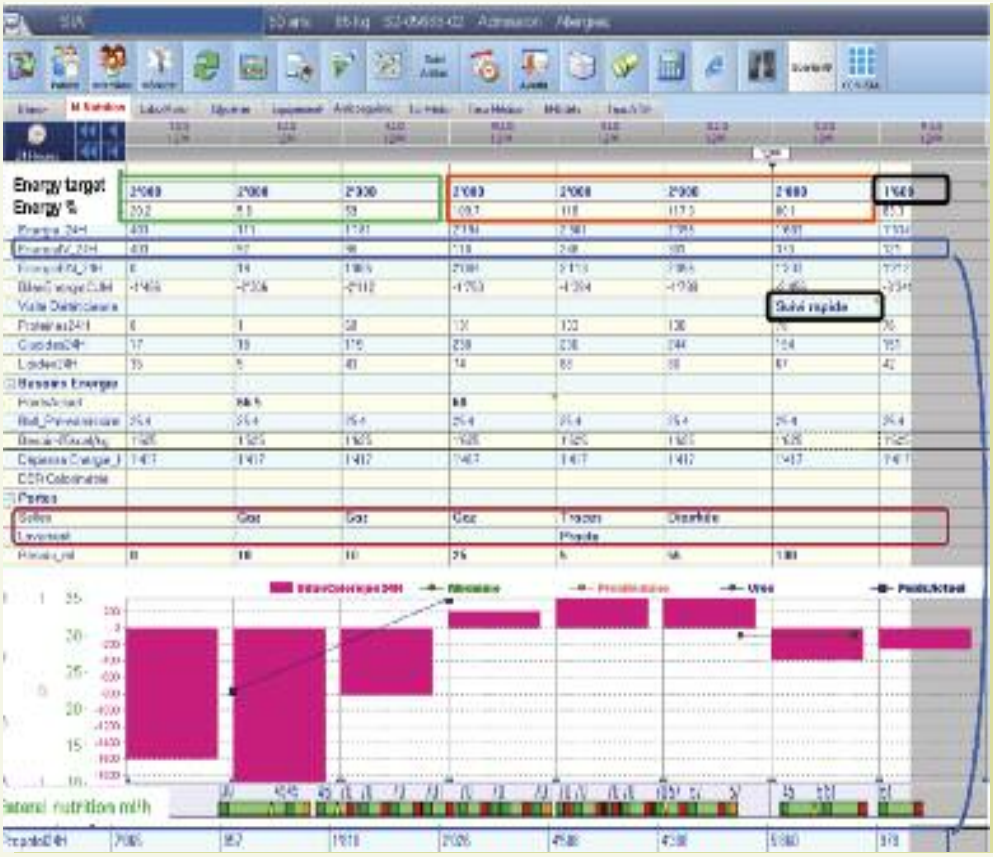


Figure 1: Screen shot of the computerised system showing 24-hour columns over eight days in a 50-year old patient with brain injury (50 kg, BMI 25.4). The dietitian observed on day seven ('suivi rapide') that the energy target was too high from start (2,000 kcal i.e. 31 kcal/kg). This was not a problem during the first three days in which EN was increasing (continuous green line on the bottom), but resulted in overfeeding from day four. This was also caused by the delivery of intravenous fat from propofol sedation (line 'Energie IV': 90-370 kcal/day – blue line). On day seven, her recommendation was to reduce the target to 1,600 kcal (i.e. 25 kcal/kg). Note that the system proposes 25 kcal/kg/d. It also shows if there is bowel activity (brown box, 'selles' = stool).

Conclusion and Perspectives

Nutrition therapy is an important tool, which supports the success of other ICU therapies and should be assigned to a nutrition specialist who is integrated into the ICU team. It has been shown that the presence of a dietitian improves nutritional support, so this should play a part in modernising the working structure, as well as supporting increasingly exhausted staff. Furthermore, this presence should help to reduce staff's uneasy feelings about nutrition competencies (Möwe et al. 2008). ■

References

AMERICAN DIETETIC ASSOCIATION (ADA) (2008). Nutrition care process and model part I: the 2008 update. J Am Diet Assoc, 108:1113-7.

Alberda C et al. (2009). The relationship between nutritional intake and clinical outcomes in critically ill patients: results of an international multicenter observational study. Intensive Care Med, 35:1728-1737.

Artinian V et al. (2006). Effects of early enteral feeding on the outcome of critically ill mechanically ventilated medical patients. Chest, 129:960-967.

Barr J et al. (2004). Outcomes in critically ill patients before and after the implementation of an evidence-based nutritional management protocol. Chest, 125:1446-57.

Casaer MP et al. (2011). Early versus late parenteral nutrition in critically ill adults. N Engl J Med, 365:506-17.

Doig GS et al. (2008). Effect of evidence-based feeding guidelines on mortality of critically ill adults: a cluster randomized controlled trial. JAMA, 300:2731-41.

Finfer S et al. (2009). Intensive versus conventional glucose control in critically ill patients. N Engl J Med, 360:1283-97.

Heidegger CP et al. (2011). Supplemental parenteral nutrition (SPN) in intensive care unit (ICU) patients for optimal energy coverage: improved clinical outcome. Intensive Care Med, 37:S107.

Heyland DK et al. (2004). Validation of the Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients: results of a prospective observational study. Crit Care Med, 32:2260-6.

Jones NE et al. (2007). Implementation of the Canadian Clinical Practice Guidelines for Nutrition Support: a multiple case study of barriers and enablers. Nutr Clin Pract, 22:449-57.

Kim JS et al. (2011) Reduction of catheter-related bloodstream infections through the use of a central venous line bundle: epidemiologic and economic consequences. Am J Infect Control, 39:640-6.

Longchamp C et al. (2007). [Implementing a feeding protocol in an adult ICU (NUTSIA): success and pitfalls]. Rev Med Suisse, 3:2844-8.

Möwe M et al. (2008). Insufficient nutritional knowledge among health care workers? Clin Nutr, 27:196-202.

Rubinson L et al. (2004). Low caloric intake is associated with nosocomial bloodstream infections in patients in the medical intensive care unit. Crit Care Med, 32:350-7.

Soguel L et al. (2012). Energy deficit and length of hospital stay can be reduced by a two-step quality improvement of nutrition therapy: The intensive care unit dietitian can make the difference. Crit Care Med, 40:412-9.

Villet S et al. (2005). Negative impact of hypocaloric feeding and energy balance on clinical outcome in ICU patients. Clin Nutr, 24:502-9.

Windle EM (2007). Adequacy of dietetic service provision to adult critical care: a survey of 33 centres in Northern England. J Hum Nutr Diet, 20:111-9; quiz 119-20.

Zilberberg MD. and Shorr AF (2011). Ventilator-associated pneumonia as a model for approaching cost-effectiveness and infection prevention in the ICU. Curr Opin Infect Dis, 24:385-9.

The easy application of transpulmonary pressure to determine optimal ventilator settings

The confident and accurate determination of optimal ventilator settings on mechanically ventilated patients, in particular Positive End Expiratory Pressure *(PEEP)*, has been likened to a 'holy grail'[1] for clinicians. This is especially true when dealing with Acute Respiratory Distress Syndrome *(ARDS)* and Acute Lung Injury *(ALI)* patients who are highly susceptible to further Ventilator-Induced Lung Injury *(VILI)*. This condition occurs through cyclical over distension and subsequent alveoli collapse resulting from inadequate, standardised ventilator settings. An optimal and lung protective strategy is dependent upon understanding the particular dynamics of each patient's disease state.

Transpulmonary pressure

To understand the individual dynamics of the respiratory system in all conditions, we would need to measure the actual pressure required to inflate the lung—the Transpulmonary Pressure *(Ptp)*, or the pressure acting across the lung from the alveoli to the pleural space. The direct measurement of Pleural Pressure *(Ppl)* would require a catheter to be inserted between the lung and the chest wall, which would be a difficult bedside procedure. Esophageal Pressure *(Pes)* variations, however, have been identified as a best available surrogate for Pleural Pressure variations[2].

Advantageously, measurement of Pes is minimally invasive, automated and easy-to-use. When Pes, measured at the end of an expiratory hold, is subtracted from Airway Pressure *(Paw)*, Transpulmonary Pressure PEEP *(PtpPEEP)* remains:

PtpPEEP = Paw – Pes *(at the end of an expiratory hold)*

The value for PtpPEEP should be ≥0cmH_2O at the end of any expiratory phase. A negative value indicates the pressure outside the lung, and therefore acting upon the lung, is greater than the pressure inside, suggesting alveoli collapse at the end of the expiratory phase. Therefore, increasing PEEP in order to maintain a PtpPEEP of ≥0cmH_2O can achieve an optimal and lung protective treatment suitable for that particular patient. A positive value, meanwhile, indicates the pressure inside the lung is greater than the pressure outside, suggesting a tendency towards over distension. Therefore, decreasing PEEP in order to maintain PtpPEEP at ≥0cmH_2O can achieve an optimal and lung protective treatment suitable for that particular patient.

Clinical example

A scenario that would explain the appearance of negative values of PtpPEEP, which is typically also the case with ARDS patients, is a condition such as obesity. In obesity, the weight of the organs generate higher intra-abdominal pressures such that the pressure in the pleural space at the end of the expiratory phase becomes greater than the pressure inside the lung, leading to alveoli collapse 'atelectasis' and lung derecruitment. Tom Piraino, RRT, Assistant Clinical Professor *(Adjunct)* at McMaster University, Hamilton, Ontario, detailed such a case in his recent article entitled *'Applying Transpulmonary Pressure in the ICU,'* which appeared in the previous edition of *ICU Management*, Volume 11, Issue 4, entitled 'Cost Effectiveness.' Improved oxygenation, ventilation *(lower minute ventilation required)*, respiratory system compliance and peak pressures below recommended limits were possible when an individualised lung protective strategy was employed using Pes to calculate Ptp and set the PEEP for a particular patient.

Talmor, Sarge, Malhotra, et al[3], in 2008, also identified

carefusion.com

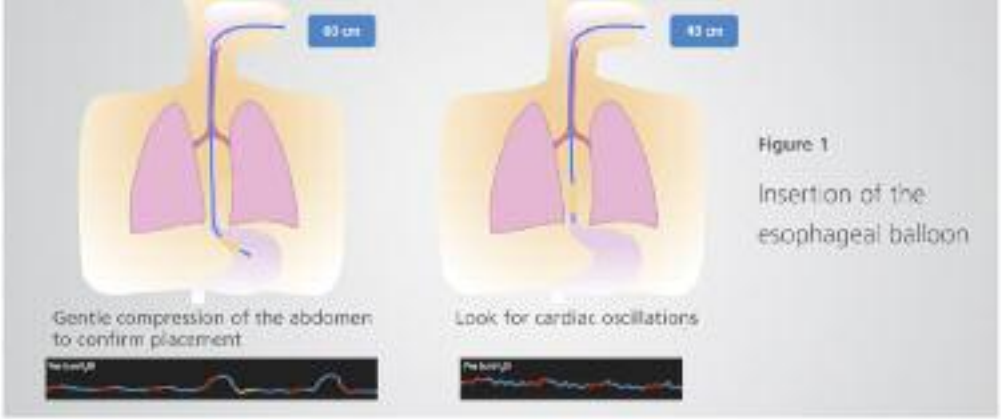


Figure 1

Insertion of the esophageal balloon

improvements in several key mortality and morbidity indicators when guided by Pes measurements to calculate Transpulmonary Pressure for the setting of optimal PEEP, when compared to the conventional ARDSnet protocols. Key indicators such as 28-day mortality, 180-day mortality, number of ICU free days at 28 days and number of ventilator free days at 28 days saw a positive trend towards improvement in this small *(n=67)* single-centre study.

AVEA® comprehensive ventilator

The AVEA comprehensive ventilator from CareFusion provides real-time, automated PtpPEEP calculations and waveforms, using Pes as a surrogate for Pleural Pressure. This measurement is performed with the simple placement of an esophageal monitoring, or naso-gastric tube with esophageal balloon, and is available in both an adult and a paediatric size. The integrated advanced mechanics inside the AVEA comprehensive ventilator enables the clinician to determine optimal ventilator settings, such as PEEP levels, as part of a targeted lung protective strategy without the addition of third-party technology or a disruption to ventilation.

Ease of use

The correct placement of the esophageal monitoring, or naso-gastric tube with esophageal balloon, can be verified by the presence of cardiac oscillations on the Pes waveform (see *Figure 1*). Once the catheter is in place and the cardiac oscillations are visible on the AVEA ventilator screen, the device is ready for a simple end expiratory hold manoeuvre to be performed. The resultant PtpPEEP value will then provide guidance to the proper course of action for the setting of an optimal PEEP based upon the negative or positive nature of the value displayed on the ventilator. Every 30 minutes, the balloon will automatically evacuate and re-inflate, whilst remaining inside the patient, in order to ensure consistent and accurate measurements at all times.

Lung protection

There are further lung protective benefits from these easy-to-use measurements on the AVEA comprehensive ventilator, such as identifying dangerous levels of Transpulmonary Plateau Pressures *(Ptp plat)*. Values for Ptp plat above the recommended limits help identify the dangers of maintaining a conventional ventilation strategy, as opposed to a more lung protective strategy such as high-frequency oscillation. Meanwhile, the ability to input Arterial Blood Gases *(ABG)* to measure Volumetric Capnography *(VCO_2)* enjoys renewed interest, providing feedback on lung perfusion amongst others factors, and thus can guide the safe and confident implementation of PEEP strategies using transpulmonary pressures.

ISICEM Symposium

During the ISICEM conference in Brussels this year, Dr. Edgar Jimenez, President of the World Federation of Societies of Intensive and Critical Care Medicine, and Dr. Onner Mörer, Assistant Medical Director Critical Care at the University of Gottingen, Germany, will be hosting an evening symposium entitled '*The Management of Lung Injury and ARDS using Transpulmonary Pressure*.' The symposium will take place on **Wednesday 21st March between 1815-1945hrs**, and will feature discussions on some of the latest clinical research on the use of Transpulmonary Pressure.

This advertorial has been written by CareFusion.

1 Sarge, T. Transpulmonary Pressure: its role in preventing ventilator-induced lung injury. Minerva Anaesthesiologica. 2008, 74:333-335.

2 Chiumello, D., Carlesso, E., Cadringher, P. et al. Lung stress and strain in ALI/ARDS. American Journal of Respiratory and Critical Care Medicine, 2008, 178.

3 Talmor, D., Malhotra, A. et al. Mechanical ventilation guided by esophageal pressure in acute lung injury. New England Journal of Medicine, November 13, 2008, 359(20).

CareFusion

THE FUTURE OF NON-INVASIVE VENTILATION

Helmet Ventilation: Advantages and Disadvantages

Fabrizio Racca, *MD*

Paediatric Anaesthesiology and Intensive Care Unit
SS Antonio Biagio e Cesare Arrigo Hospital
Alessandria, Italy

fabrizio.racca@gmail.com

Elena C. Capello, *MD*

Department of Anaesthesiology and Intensive Care
University of Turin, S. Giovanni Battista-Molinette Hospital
Turin, Italy

Jenny Gualino, *MD*

Paediatric Anaesthesiology and Intensive Care Unit
SS Antonio Biagio e Cesare Arrigo Hospital
Alessandria, Italy

V. Marco Ranieri, *MD*

Department of Anaesthesiology and Intensive Care
University of Turin, S. Giovanni Battista-Molinette Hospital
Turin, Italy

Introduction

Non-invasive ventilation (NIV) provides safe and effective assistance to patients with acute respiratory failure (ARF) from various causes (Garpestad et al. 2007). The main reason for applying NIV is to avoid the complications of endotracheal intubation, according to Evans et al. (2000). The ventilator setting generally used to apply NIV is Pressure Support Ventilation (PSV), delivered via an oronasal mask (Garpestad et al. 2007); however, the application of NIV through a mask can be complicated by other problems, causing discomfort such as major air leaks, eye irritation, skin breakdown and patient-ventilator asynchrony. Carlucci et al. (2001) reported that discomfort is one of the major determinants of NIV failure, therefore, in the past decade both researchers and manufacturers have been working to increase patient comfort during NIV, both by improving conventional interfaces and developing new interfaces, such as the helmet.

Advantages of Helmet Ventilation

The helmet, consisting of a transparent, latex-free, polyvinyl chloride (PVC) hood, joined by a plastic ring to a soft collar, has been proposed to deliver continuous positive airway pressure (CPAP) and NIV.

Several models of helmet with different designs and materials are available for clinical use: the Starmed Castar (Mirandola, Italy), the Rusch 4Vent (Mirandola, Italy), the Sea-Long (Louisville, Kentucky, USA), etc.

Helmet ventilation has the unique feature of avoiding direct contact with the facial skin. The lack of pressure points on the face increases patient comfort and reduces the risk of skin breakdown. In recent non-randomised studies the helmet PSV ventilation method improved gas exchange with a better tolerance and a lower rate of complications than the mask PSV ventilation method, both in hypoxemic (Antonelli et. al 2002) and hypercapnic (Antonelli et. al 2004) ARF. It also increased the number of hours of continuous NIV use. Furthermore, the helmet can be applied to any patient regardless of their facial contour, decreasing air leaks and lowering nurse workload.

Disadvantages of Helmet Ventilation

The physical characteristics of the helmet (i.e. the large internal volume and the highly compliant soft collar: see Table 1) may over-damp the pressure rise inside the helmet itself, affect both the inspiratory trigger and the inspiration-to-expiration switch algorithms of the ven-

> *"the helmet PSV ventilation method improved gas exchange with a better tolerance and a lower rate of complications than the mask PSV ventilation method"*

Table 1. The physical characteristics of the helmets

	Sizes available	Internal Volume (l)	Compliance (ml/cmH_2O)
Starmed Castar	3 sizes	**11.5** for the small size	50
Rusch 4Vent	3 sizes	**12** for the small size	48
Sea-Long	Single size	**16**	68

tilator, and favour carbon dioxide (CO_2) accumulation, leading to patient-ventilator asynchrony, impaired unloading efficacy of the respiratory muscles, and CO_2 re-breathing (Racca et al. 2005; Costa et al. 2005; Taccone et al. 2004).

Patient-Ventilator Asynchrony

The inspiratory flow inside the helmet exceeds more than threefold the subject's inspiratory flow (Racca et al. 2005). Because the algorithms regulating the beginning and end of PSV are pressure and flow based, an influence of the helmet's characteristics on the ventilator triggering functions should be expected. Moreover, the highly compliant soft collar over-damps the pressure rise inside the helmet. Indeed, Racca et al. (2005) and Navalesi et al. (2007) have shown that:

1) The inspiratory trigger delay was significantly higher during helmet ventilation than during mask ventilation, indicating that the helmet has poor trigger sensitivity;
2) The speed of pressurisation was significantly lower during helmet ventilation than during mask ventilation;
3) The ventilator assistance was cycled off by the changes in flow caused by the mechanical characteristics of the helmet rather than by the changes in flow caused by the subject's mechanical characteristics and muscle effort; thus, the termination of ventilator support could anticipate or follow the termination of the subject's inspiratory effort; and
4) Wasted efforts and autocycled breaths occurred more frequently with the helmet ventilation than with the oronasal mask.

A comparative bench study carried out by Costa et al. (2008) suggested that different types of helmet may perform differently in delivering PSV.

Impaired Unloading Efficacy of the Respiratory Muscles

Some studies found the helmet to be less efficient than the mask in reducing inspiratory effort (Racca et al. 2005; Navalesi et al. 2007). Indeed, a substantial portion of the inspiratory flow serves to expand the helmet, whose large inner volume and high compliance lead to dissipation of the inspiratory pressure delivered by the ventilator. Moreover, during helmet ventilation, subjects had to double minute ventilation to maintain values of end-tidal PCO2 similar to those observed during mask ventilation (Racca et al. 2005). Finally, some portion of inspiratory effort is unassisted by the positive pressure boost delivered by the ventilator because of patient-ventilator uncoupling (Racca et al. 2005; Navalesi et al. 2007)

CO_2 Rebreathing

There exists some concern about CO_2 rebreathing during helmet application: with every breath, the CO_2 expired by the patient does not completely leave the system, but partly dilutes within the internal volume of the helmet and is subsequently re-inhaled. As a matter of fact, for patients with acute exacerbations of chronic obstructive pulmonary disease, the helmet was less efficient than the face mask in CO_2 elimination, identified Antonelli et al. (2004). Recently, Taccone et al. (2004) and Mojoli et al.(2008) demonstrated that during both CPAP and NIV delivered by helmet, the magnitude of rebreathing is directly related to the patient's CO_2 production and inversely related to the total flow passing through the helmet. Therefore, it has been suggested that only the helmet with high (40 to 60 L/min) continuous-flow CPAP systems be used (Taccone et al. 2004). However, in contrast to CPAP, during NIV the fresh gas flow applied to the helmet is limited (i.e. it is always lower than 40 L/min) and typically intermittent, leading to significant CO_2 rebreathing (Racca et al. 2005).

Possible Solutions

Specific Ventilator Settings

All the physiologic studies comparing the helmet and the mask were performed using the same ventilator settings for the two interfaces. Recently, a study conducted by Vargas et al. (2009) and Costa et al. (2010) noted a significant improvement in patient–ventilator interaction and patient tolerance when delivering helmet PSV ventilation with specific settings.

Vargas et al. (2009) applied helmet PSV to patients requiring early NIV after extubation, increasing by 50% the baseline inspiratory and expiratory pressures used to deliver NIV through the oronasal mask, and applying the fastest pressurisation rate. They observed that, when used with specific settings, helmet PSV provided similar unloading to mask PSV and improved the inspiratory triggering delay. These results were attributed to an improved pressure and flow transmission, and lower helmet compliance due to higher positive end-expiratory pressure (PEEP).

> *"the choice of a fast inspiratory ramp and a fast expiratory trigger can improve patient-ventilator interaction"*

Cycling off the ventilator is also an important component of the synchrony between the patient and the ventilator. In a physiological study, Costa et al.(2010) showed that the choice of a fast inspiratory ramp and a fast expiratory trigger (i.e. a cycling-off threshold of 60% of the peak inspiratory flow) can improve patient–ventilator interaction, especially when there is a high respiratory rate (RR).

In a recent paper, Mojoli et al. (2008) showed that CO_2 rebreathing can be lowered during helmet ventilation by increas-

ing inspiratory pressure or adding a flow-by (i.e., a flow-by of 8-L/min). Indeed, these ventilator manipulations produced a progressive increase in the minute ventilation of the whole system.

Using a different ventilator modality such as biphasic positive airway pressure (BIPAP) results in further improvements, indicated Racca et al. (2009). Helmet BIPAP provided by ICU ventilators was successfully used as an alternative to helmet PSV in neuromuscular patients. Here, helmet PSV caused significant patient-ventilator asynchrony, leading to NIV intolerance. Thus, the ventilator was switched to helmet BIPAP with a RR and Ti set as close as possible to patient's RR and timing. This ventilator setting improved gas exchange and patient-ventilator interaction, allowing successful NIV.

Finally, Isgrò et al. (2010) applied periodical high pressure breaths (SIGH) during helmet CPAP in patients with acute ARF, using a recently developed electromechanical expiratory valve, which is time cycled between two customisable PEEP levels. When compared to basal CPAP, SIGH induced a further significant increase in partial pressure of oxygen (PaO_2).

Neural Triggered Helmet Ventilation

An evaluation by Sinderby et al. (1999) concluded that new methods for neural triggering and cycling-off, using the diaphragm electrical activity (EAdi), can be used to initiate and terminate ventilatory assistance in synchrony with inspiratory efforts. Measurement of the EAdi requires that a catheter be inserted transnasally into the stomach. Because the ventilator is directly triggered by EAdi, the synchrony between neural and mechanical inspiratory time is guaranteed both at the onset and at the end of inspiration, regardless of the physical characteristics of the helmet. Indeed, Moerer et al. (2008) demonstrated in healthy subjects that patient–ventilator synchrony, trigger effort, and breathing comfort with a helmet interface are considerably less impaired during increasing levels of PSV and RR, and with neural triggering and cycling-off, compared to conventional pneumatic triggering and cycling-off. However, adding an oesophageal catheter is uncomfortable and this insertion could be difficult in patients with ARF. Furthermore, several doubts remain regarding the long-term stability of the EAdi signal during NIV.

The New Helmet

Researchers and manufactures are working to develop a new helmet. A decrease of the inner volume and/or use of less compliant materials should be made in order to improve patient-ventilator synchrony and the unloading efficacy of respiratory muscles during helmet ventilation.

Conclusion

Although, we believe that the helmet can completely replace the mask to apply CPAP, its use for application of NIV should, at present, only be recommended as part of a rotating strategy of different interfaces in order to reduce NIV side effects and allow NIV application for a higher number of continuous hours, primarily in hypoxemic patients. It is also worth highlighting the need to increase the value of inspiratory and expiratory pressure, and to choose a fast inspiratory ramp and a fast expiratory trigger when switching from the mask to the helmet. Should helmet PSV failure occur, despite specific ventilator settings, BIPAP or neural triggered ventilation may be used to provide helmet ventilation. ■

References

Antonelli M et al. New treatment of acute hypoxemic respiratory failure: Noninvasive pressure support ventilation delivered by helmet—A pilot controlled trial. Crit Care Med (2002); 30:602–608.

Antonelli M et al. Noninvasive positive pressure ventilation using a helmet in patients with acute exacerbation of chronic obstructive pulmonary disease: A feasibility study. Anesthesiology (2004); 100:16–24.

Carlucci A et al. Noninvasive versus conventional mechanical ventilation. An epidemiologic survey. Am J Respir Crit Care Med (2001); 167:874–880.

Costa R et al. Comparative evaluation of different helmets on patient–ventilator interaction during noninvasive ventilation Intensive Care Med (2008); 34:1102–1108.

Costa R et al. Influence of ventilator settings on patient–ventilator synchrony during pressure support ventilation with different interfaces Intensive Care Med (2010); 36:1363–1370.

Garpestad E et al. Noninvasive Ventilation for Critical Care. Chest (2007); 132:711–720

Evans TW. International Consensus Conferences in Intensive Care Medicine: Noninvasive positive pressure ventilation in acute respiratory failure. Intensive Care Med (2000); 27:166–178.

Isgrò S et al. Continuous flow biphasic positive air way pressure by helmet in patients with acute hypoxic respiratory failure: effect on oxygenation Intensive Care Med (2010);36:1688–1694.

Moerer O et al. Subject ventilator synchrony during neural versus pneumatically triggered non-invasive helmet ventilation. Intensive Care Med (2008); 34:1615–1623 .

Mojoli F et al. Carbon dioxide rebreathing during non-invasive ventilation delivered by helmet: a bench study. Intensive Care Med (2008); 34:1454-1460.

Navalesi P et al. Noninvasive ventilation in chronic obstructive pulmonary disease patients: Helmet versus facial mask. Intensive Care Med (2007); 33:74–81.

Racca F et al. Effectiveness of mask and helmet interfaces to deliver noninvasive ventilation in a human model of resistive breathing. J Appl Physiol (2005); 99:1262–1271.

Racca F et al. Helmet ventilation for acute respiratory failure and nasal skin breakdown in neuromuscular disorders. Anesth Analg (2009); 109:164–167.

Sinderby C et al. Neural control of mechanical ventilation in respiratory failure. Nat Med (1999); 5:1433–1436.

Taccone P et al.. Continuous positive airway pressure delivered with a "helmet": effects on carbon dioxide rebreathing. Crit Care Med. (2004); 32(10):2090-6.

Vargas F et al. Helmet with specific settings versus facemask for noninvasive ventilation. Crit Care Med (2009); 37:1921–1928.

FLUID OVERLOAD IS NOT ONLY OF COSMETIC CONCERN

Exploring a New Hypothesis

Manu LNG Malbrain, *MD, PhD*
Director
ICU and High Care Burn Unit
ZNA Stuivenberg
Antwerp, Belgium

manu.malbrain@skynet.be

Niels Van Regenmortel, *MD*
Intensive Care Unit
ZNA Stuivenberg
Antwerp, Belgium

Introduction

Capillary leak complicates conditions that are characterised by inflammation, infection and resuscitation. It is important to understand the pathophysiologic basis in order to minimise fluid, electrolytes, proteins and other molecules that extravasate from the vascular space into the interstitium. Capillary leak not only contributes to peripheral but also organ oedema, as well as pleural effusions and ascites that accompany large volume resuscitation. As such, capillary leak significantly contributes to the genesis of intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS). Recently, more evidence has become available, alluding to the deleterious effects of fluid accumulation. In this paper we hypothesise on an old theory related to this topic: the three hit model of shock (Malbrain and De Laet 2008).

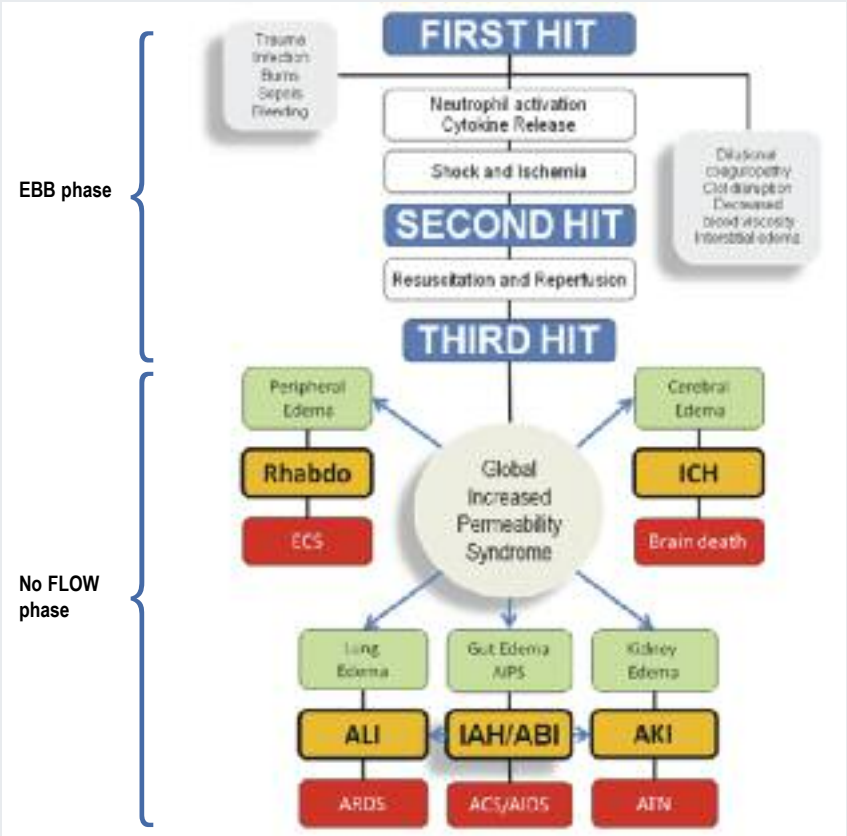
Background

The concept of dual metabolic response to bodily injury was introduced as early as 1942. In direct response to initial proinflammatory cytokines and stress hormones, the ebb phase represents a distributive shock characterised by arterial vasodilatation and transcapillary albumin leak abating plasma oncotic pressure. Arterial underfilling, microcirculatory dysfunction and secondary interstitial oedema lead to systemic hypoperfusion and regionally impaired tissue use of oxygen. In this early stage of shock, adequate fluid therapy comprises adequate goal directed filling to prevent evolution to multiple organ dysfunction syndrome (MODS). As compensatory neuroendocrine reflexes and potential renal dysfunction could result in sodium and water retention, positive fluid balances are inherent to the ebb phase. Patients with a higher severity of illness need more fluids to reach cardiovascular optimisation; therefore, at this point fluid balance may be considered a biomarker of critical illness (Bagshaw and Bellomo 2007). Patients overcoming shock typically attain homeostasis of proinflammatory and anti-inflammatory mediators within three days. Subsequent haemodynamic stabilisation and restoration of plasma oncotic pressure set off the flow phase with resumption of diuresis and mobilisation of extravascular fluid, resulting in negative fluid balances.

The Three Hit Model of Shock

Recent studies have shown that the application of conservative late fluid management (CLFM), with two consecutive days of negative fluid balance within the first week of stay, offers a strong chance of survival (Murphy et

Figure 1: The Three Hit Model of Shock



Legend
Rhadbo: rhabdomyolysis, ECS: extremity compartment syndrome, ICH: intracranial hypertension, ALI: acute lung injury, ARDS: acute respiratory distress syndrome, IAH: intra-abdominal hypertension, ABI: acute bowel injury, ACS: abdominal compartment syndrome, AIDS: acute intestinal distress syndrome, AKI: acute kidney injury, ATN: acute tubular necrosis, GIPS: global increased permeability syndrome

al. 2009). In contrast, patients with persistent systemic inflammation maintain transcapillary albumin leak and do not reach the flow phase, mounting up positive fluid balances. In this context, the global increased permeability syndrome (GIPS) has been introduced, characterised by a high capillary leak index (CLI, expressed as CRP over albumin ratio), excess interstitial fluid, persistent high extravascular lung water index (EVLWI), no CLFM achievement and progressing organ failure (Cordemans et al. 2012). GIPS represents a third hit, following the acute injury (as first hit) with progression to MODS (as the second hit) (Malbrain and De Laet 2008). The third hit may develop in patients that do not enter the flow phase spontaneously. Figure 1 summarises this three hit model.

The dual response to acute inflammatory insult is characterised by a crucial turning point on day three. Presumably, homeostasis of cytokines on the third day after shock onset allows initiation of healing the microcirculatory disruptions and closure of capillary leak. This interpretation is supported by observations demonstrating normalisation of microcirculatory blood flow on day three in patients with abdominal sepsis. Lower EVLWI and pulmonary vascular permeability indices on day three of shock have been shown to correlate with better survival (Kuzkov et al. 2006).

Table 1. Risk factors for the development of IAH and ACS

Risk factors related to capillary leak and fluid resuscitation
Acidosis* (pH below 7.2)
Hypothermia* (core temperature below 33°C)
Coagulopathy* (platelet count below 50,000/mm³; or an activated partial thromboplastin time (APTT) more than two times normal; or a prothrombin time (PTT) below 50%; or an international standardised ratio (INR) more than 1.5)
Polytransfusion / trauma (>10 units of packed red cells / 24 hours)
Sepsis (as defined by the American – European Consensus Conference definitions)
Severe sepsis or bacteraemia
Septic shock
Massive fluid resuscitation (>5 litres of colloid or >10L of crystalloid / 24 hours with capillary leak and positive fluid balance)
Major burns

**The combination of acidosis, hypothermia and coagulopathy has been forwarded in literature as the deadly triad*

Polycompartment Syndrome

In cases of capillary leak and the impaired flow stage, overzealous administration of fluids in the GIPS phase will lead to gross fluid overload and tissue oedema. Interstitial oedema raises the pressure in all four major body compartments: head, chest, abdomen and extremities, and as a result,

venous resistance of organs within compartments increases and perfusion pressure decreases, contributing to the progression of organ failure. As different compartments interact and reciprocally transmit compartment pressures, polycompartment syndrome is suggested to occur (Malbrain and Wilmer 2007; Malbrain and De Laet 2008 and 2009).

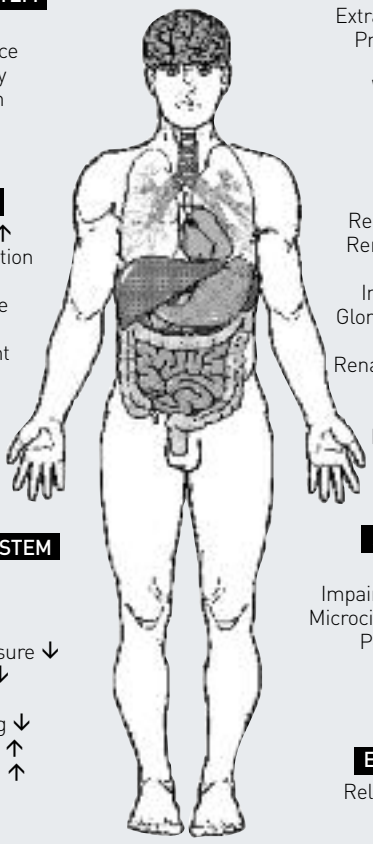
The abdomen plays a central role in GIPS and polycompartment syndrome, as positive fluid balances are a known risk factor for secondary intra-abdominal hypertension (IAH), which is in turn associated with adverse effects on other compartments and organ functions (Malbrain et al. 2006).

Pathophysiology

Renal function in particular is strongly affected by IAH. Furthermore, renal interstitial oedema in absence of IAH may impair renal function. Therefore, fluid overload leading to IAH and associated renal dysfunction may counteract its own resolution (Table 1) (De Laet et al. 2007). The adverse effects of fluid overload and interstitial oedema are numerous and have an impact on all endorgan functions, as illustrated in Figure 2, although some colleagues recently suggested that peripheral oedema is only of cosmetic concern (Pinsky 2007).

When adverse effects of fluid overload in states of capillary leak are particularly pronounced in the lungs, monitoring of EVLWI may be a valuable tool in the guidance of fluid management in the critically ill. A high EVLWI indicates a state of capillary leak associated with a higher severity of illness and mortality, and recent studies have correlated EVLWI with albumin extravasation in patients

Figure 2: Pathophysiologic effects of fluid overload on endorgan function



Legend
IAP: *intra-abdominal pressure,*
IAH: *intra-abdominal hypertension,*
ACS: *abdominal compartment syndrome*
ICH: *intracranial hypertension,*
ICS: *intracranial compartment syndrome,* ***OCS:*** *ocular compartment syndrome*

Table 2. The 3 hit model of shock

	First hit	Second hit	Third hit
Cause	Inflammatory insult	Ischemia reperfusion	GIPS
Phase	Ebb	Flow	No flow
Fluids	Life saving	Biomarker of critical illness	Toxic
Monitoring	Functional haemodynamics (SVV, PPV)	Organ function (EVLWI, IAP)	Perfusion (ICG-PDR)
Treatment	Early adequate goal directed fluid management (EAGD)	Late conservative fluid management (LCFM)	Late goal directed fluid removal (LGFR)
Fluid balance	Positive	Neutral	Negative

Legend
SVV: *stroke volume variation,* ***PPV:*** *pulse pressure variation,* ***EVLWI:*** *extravascular lung water index,* ***IAP:*** *intra-abdominal pressure,* ***ICG-PDR:*** *indocyanine green plasma disappearance rate*

after multiple trauma.

Responders to CLFM overcome the distributive shock and make a transition to the flow phase; however, non-responders stay in the grip of the ebb phase and progress to GIPS, resulting in positive fluid balances, organ failure and death. In this hypothesis, (change in) EVLWI has a prognostic value as a reflection of the extent of capillary leak, rather than as a quantification of lung function impairment by lung water (Cordemans et al. 2012). These recent observations are important to bear in mind when making decisions on fluid management in critically ill patients with IAH. Patients at risk for GIPS, as assessed by CLI, IAP, changes in EVLWI and fluid balance, require restrictive fluid strategies and even fluid removal guided by extended haemodynamic monitoring, including lung water measurements (late goal directed fluid removal). Previously, the application of EVLWI-guided fluid therapy led to improved outcomes and lower positive fluid balances in states of capillary leak (Mitchell et al. 1992). Restrictive fluid management may necessitate a greater use of vasopressor therapy, resuscitation with hyperoncotic solutions (e.g. albumin 20%), and early initiation of diuretics and renal replacement therapy.

Within the concept of dual response to shock, it is possible to identify patients with persistent capillary leak that do not reach the flow phase. In this context, GIPS reflects a third hit of shock, which arises after acute injury and MODS. In those patients, superfluous fluid administration results in oedema formation, progression of organ failure and worse outcomes, and may be considered toxic (Table 2). Therefore, as soon as haemodynamics allow, early transition to conservative fluid management and even fluid removal on the basis of EVLWI-guided protocol is mandated (late goal directed fluid removal) (Malbrain and De Laet 2008; Murphy et al. 2009; Cordemans et al. 2012; Cordemans et al. 2012).

Key Message

Capillary leak is an inflammatory condition with diverse triggers that results from a common pathway, including ischemia-reperfusion, toxic oxygen metabolite generation, and cell wall and enzyme injury, leading to a loss of capillary endothelial barrier function. In this circumstance, plasma volume expansion to correct hypoperfusion predictably results in extravascular movement of water, electrolytes and proteins. Peripheral tissue oedema, visceral oedema and ascites may be anticipated in proportion to the volume of prescribed resuscitation fluid; thus, a variety of strategies are available to the clinician to reduce the volume of crystalloid resuscitation utilised while restoring macro- and microcirculatory flow. Regardless of the resuscitation strategy, the clinician must maintain a heightened awareness of the dynamic relationship between capillary leak, fluid loading, peripheral oedema, intra-abdominal hypertension and abdominal compartment syndrome. ■

References

For references please send a request to **editorial@icu-management.org**

DECREASING CENTRAL LINE ASSOCIATED BACTERAEMIA IN A NEW ZEALAND INTENSIVE CARE UNIT:

Putting Evidence into Practice

Mary E Seddon, *MBChB, MPH*

Clinical Director
Centre for Quality Improvement
Ko Awatea
Counties – Manukau District Health Board
Auckland, New Zealand

MZSeddon@middlemore.co.nz

Introduction

Central venous catheters are commonly used in intensive care units, with studies suggesting that approximately 50% of ICU patients have such lines inserted. Meanwhile, central line infections are responsible for 40-60% of bloodstream infections in intensive care patients, according to New South Wales Health (November 2008). These incidents are known as central line associated bacteraemia (CLAB) and they significantly increase morbidity and mortality rates (Pittet et al. 1994; Soufir et al. 1999), as well as cost for the hospital system (Shannon et al. 2006).

> *"To foster a buy-in to the changes, we were keen to make the 'right' thing the 'easiest' thing to do, so we commissioned a central line insertion pack"*

A number of approaches have been used to decrease the risk of infection with central lines, with The Centres for Disease Control (CDC) 2002 guidelines (O'Grady N et al. 2002) emphasising the importance of aseptic insertion of central lines. Educational programmes encouraging this approach have successfully reduced CLAB rates (Coopersmith et al. 2002). A study by Berenholtz et al. (2004) demonstrated that CLAB rates could be dramatically reduced by using a quality improvement approach. Firstly, at Johns Hopkins Hospital, where rates fell from 11.3 to 0/1,000 line days, and then, in a large collaborative study in Michigan State. This involved 103 ICUs (85% of the ICU beds in that state) showing an 81% reduction in the mean rate of line days, which was estimated to have saved over 1,500 lives, 81,000 hospital days and 165 million US dollars (Pronovost et al. 2006). A recent Australian collaborative quality improvement project involving 37 ICUs also showed a reduction in CLAB rates from 3.0 to 1.2/1,000 line days (Burrell et al. 2011).

Given this evidence we decided to implement a multi-faceted quality improvement programme to reduce the CLAB rate at Middlemore Hospital's Critical Care Complex, which in 2008 stood at 6.8/1,000 line days. Middlemore Hospital in Manukau City, New Zealand is an 800-bed facility that provides secondary and tertiary services to a population of 450,000. Throughout the programme, the seven beds provided in the ICU were increased to 12, with a six-bedded high dependency unit (HDU) added. This paper summarises the issues faced, what we did, our results, and the lessons learned.

Methods

We used the Institute for Healthcare Improvement's CLAB prevention guide (2006) as the blueprint for our work, and used the CDC definition of a CLAB. In simple terms, a CLAB is defined as a significant bloodstream infection with no other obvious focus of infection, that occurs in a patient who either has a central line in place or had one applied within 48 hours of the blood cultures being taken (O'Grady et al. 2002).

Clinician Buy-In

Resistance to the programme from clinicians seemed to fall into four areas:

1. Denial that our rates were high and subsequent rejection that CLAB reduction was important;
2. Scepticism that a method used in the US would be applicable in New Zealand;
3. Unfamiliarity with a quality improvement approach, as opposed to the classic biomedical model. This challenged many of the clinicians who wanted large-scale trials, preferably randomised, on each and every aspect of the bundle; and
4. Resistance to standardisation of practice. We acknowledged that it was not useful to standardise most aspects of clinical decision-making, but that when the decision was made to insert a central line, it was useful to have a standardised approach to this. As Pronovost (2010) said, when placing a catheter, reliability not autonomy is needed.

Dixon-Woods et al. (2011) also identified resistance from doctors who were concerned that nurses would be monitoring their behaviour. The same study identified resistance from nurses who worried that doctors might react to being challenged. This was not an issue in our ICU, but these same sentiments were expressed in another department as we spread the programme throughout the hospital.

To build the will for change we pre-

sented the results from Michigan (Pronovost et al. 2006), and after many months of discussion, the Clinical Director of the Critical Care Complex made the decision to adopt the CLAB prevention bundle of care.

The CLAB prevention bundle was debated and then modified, with the team agreeing on four out of the five components:

1. Hand hygiene;
2. Chlorhexidine skin antisepsis (chlorhexidine 2% in 70% alcohol);
3. Maximum barrier precautions (hat, mask, sterile gloves, sterile gown and full patient drape); and
4. Daily review of the need for the line, with prompt removal of unnecessary lines.

The fifth component, using the subclavian as the preferred approach, was rejected by ICU staff, with evidence from Deshpande et al. (2005) supporting such decision. This modified bundle was incorporated into two checklists: one for line insertion, and one for daily maintenance of the lines (see Box 1). The layout of the checklists was modified over several months, following staff suggestions and investigation of CLAB cases (Seddon et al. 2011).

Box 1. Key elements of checklists

Central line insertion checklist

- Hand Hygiene;
- Chlorhexidine skin anti-sepsis; and
- Maximal barrier precautions – hat, mask, sterile gloves and gown for inserter, and large sterile drape to cover entire patient.

Central line maintenance checklist

- Daily line necessity review;
- Chlorhexidine to clean ports before every access;
- Daily site check; and
- Dedicated port for total parenteral nutrition (TPN).

Keeping Momentum and Holding the Gains

We used visual feedback of results to build momentum. In a prominent place in the unit we displayed the:

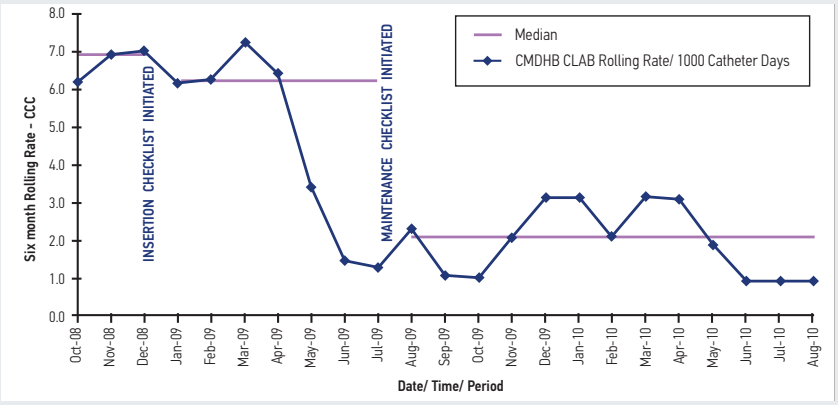
- Days since the last CLAB. As we went on, CLABs became quite rare events and it was decided that the most useful way of showing this change was to display how many days there had been since our last CLAB. This was updated daily;
- Weekly compliance with the checklists. Initially this was a monthly figure, but this did not seem to have immediacy and also meant that we were too slow to detect drops in performance; and
- A six-month rolling rate of CLAB /1,000 line days. Although this rate smoothes the data and takes some months to show changes, it was the most useful visual feedback for medical clinicians (see Figure 1).

Table 1. CLAB results for first 18 months

	2008	2009	2010
CLAB cases	14	4	1
Median days between CLAB cases	28.1	75.8	N/A
CLAB/1,000 line days	6.8	3.0	0.9
Cost of CLAB cases in NZD (Burns et al. 2010)	$280,000	$80,000	$20,000

Since publication of the study, we have continued to see months with zero CLAB – nine in 2010 and eight in 2011.

Figure 1. CLAB rate per 1,000 line days (six month rolling rate)



In the event of infection, each CLAB was defined as a sentinel occurrence and investigated. This reinforced for staff that CLABs were not just a part of everyday care for very sick patients.

Investigating these sentinel events also led to improvements as we were able to identify patients at high risk of CLAB: patients with severe immunosuppression, those receiving TPN, or those with large burns. For these patients a chlorhexidine biopatch was added, and antibiotic-impregnated lines considered. Also at high risk were those that had lines inserted under emergency conditions, or in another hospital. These were flagged and lines were replaced at the earliest opportunity. The checklist was amended to check whether the patient fitted the high-risk criteria.

To further foster buy-in to the changes, we were keen to make the right thing to do the easiest thing to do, so we commissioned a central line insertion pack. This pack contained everything that was needed to insert a central line and was designed in such a way that it led the doctor through best practice. For example, the pack came with the insertion checklist, and on opening the pack, the first things encountered were the sterile hat and gloves.

Compliance with the insertion and maintenance checklists was measured using an 'all or none' measure (Nolan and Berwick 2006), which specifies that all

Continues on page 42

AN EMERGING CONSENSUS FOR ACUTE KIDNEY INJURY

John A. Kellum, *MD, FACP, FCCM*

Professor and Vice Chair for Research
Department of Critical Care Medicine
University of Pittsburg
Pittsburgh, USA

kellumja@ccm.upmc.edu

Claudio Ronco, *MD*

Director
Department of Nephrology Dialysis & Transplantation
International Renal Research Institute (IRRIV)
San Bortolo Hospital
Vicenza, Italy

cronco@goldnet.it

Michael Joannidis, *MD*

Associate Professor and Director
Medical Intensive Care Unit
Department of Internal Medicine
Medical University Innsbruck
Innsbruck, Austria

michael.joannidis@i-med.ac.at

Acute kidney injury (AKI) is a hot topic in the medical arena, with prominent research and discussion ongoing, prompting amendments to recommended practice. The Acute Kidney Injury Network (AKIN) and Acute Dialysis Quality Initiative (ADQI) and AKI section of the European Society Intensive Care Medicine (ESICM) continue to work on counsel for clinical practice and research, while new guidelines from Kidney Disease: Improving Global Outcomes (KDIGO) are published recently (Kidney International, March 2012). For this issue of ICU Management, we asked three influential figures in the field, John Kellum, Professor of Critical Care Medicine at the University of Pittsburgh, USA; Claudio Ronco, Professor of Nephrology Dialysis & Transplantation, based at San Bortolo Hospital, Vicenza, Italy; and Michael Joannidis, Associate Professor of Intensive Care at the Medical University Innsbruck, Austria to provide their opinions on developments within the field.

What does the emerging consensus recommend for early identification and definition of AKI?

John Kellum: It is now clear that patients may present with evidence of AKI or they may acquire it after hospitalisation. It is also clear that patients with and without preexisting chronic kidney disease (CKD) are at risk. For these reasons, the criteria for AKI must allow for either a change in function from baseline, or a small ongoing change under observation. The AKIN modification to the original RIFLE criteria (see Table 1) allows for either scenario and thus represents the best way to define AKI. It is not sufficient to simply use the original RIFLE criterion for creatinine because patients with elevated baseline creatinine would be too often missed. Furthermore, it is unacceptable to require ongoing increases in creatinine to define AKI, since patients with community acquired AKI may present their worst creatinine. The just published KDIGO has further clarified these points.

Another significant issue that has been highlighted is that serum creatinine is not a very good early marker of AKI and better markers are needed. Changes in urine flow occur earlier than creatinine but they lack sensitivity and specificity. New biomarkers like NGAL, KIM-1, IL-18 and FABP are being validated for the use in early identification of AKI and have the potential to change clinical practice.

How important is the early identification of acute kidney injury?

John Kellum: It is very important. Like most diseases, AKI is harder to treat when it is detected late, resulting in lower chances of recovery. In the early stages of AKI, kidney cells are usually still viable, and the potential exists to mitigate disease progression with effective therapy.

Is the prevention of AKI possible?

John Kellum: Yes, without a doubt. Many cases of AKI occur in already hospitalised patients and appear to be the result of multiple insults, including nephrotoxic drug exposure, radio contrast, and sepsis. Careful attention to these exposures in high risk patients will reduce the incidence of AKI. However, most cases of AKI are caused by conditions that are not modifiable, and often in these instances patients present an already advanced disease. For these patients, the focus of medical care should be on reducing continued injury and facilitating renal recovery.

What is the best intervention to prevent acute kidney injury in the critically ill?

John Kellum: There is no single method for prevention of AKI. Avoidance of unnecessary nephrotoxins, and rapid and effective treatment of infection are likely to be the most efficient preventative measures, while ensuring adequate intravascular volume status and avoiding volume overload are also paramount. Effective volume management is not merely giving fluid for low urine output and then attempting to take it away with diuretics. It is important to understand that once the kidney is injured, urine output is no longer a useful gauge of fluid status; therefore, the physician must seek other methods to determine the right amount of fluid to be given. This may include functional haemodynamic monitoring such as pulse-pressure variation.

Michael Joannidis: In this context it should be added that the paradigm of fluid management is currently changing and first data have been presented indicating that under the condition of sufficient haemodynamic stability, keeping patients on the 'dryer' side may protect

Early. Check. Easy. Check.

Introducing the first real advance in acute kidney injury testing in more than 60 years, the NEPHROCHECK™ Test by Astute Medical. Unlike traditional renal tests that can take hours or days to provide results, these revolutionary, never-before-seen, early-rising biomarkers provide specific, accurate results in just minutes.

For details, visit CheckAKIRisk.com.

ASTUTE MEDICAL™

innovative biomarkers. Smarter healthcare.

renal function even more effectively than unguided fluid loading.

In cases of liver failure, what can we do to prevent acute renal failure from developing?

Michael Joannidis: Preservation of renal function in chronic liver cirrhosis consists of applying hyperoncotic albumin in combination with vasopressors (e.g. terlipressin). Furthermore, early antibiotic treatment is recommended for any signs of infection as well as episodes of gastrointestinal bleeding

What can we do to prevent acute renal failure from developing in patients with lung injury?

Michael Joannidis: Currently, no specific interventions in addition to the general measures described above by John Kellum and myself have proven efficient in the setting of lung injury. Fluid restriction may help both the lung and the kidney in this setting as long as adequate renal perfusion is granted. Furthermore, limiting additional inflammatory injury from mechanical ventilation by applying non invasive ventilation or reducing strain through low tidal volumes if intubation cannot be avoided results in lower circulation cytokine levels and reduced rates of AKI.

Have any preventative developments been made in cases of cardiac surgery?

Michael Joannidis: The use of vasodilators (e.g. fenoldopam) or inodilator (e.g. levosimendan) has been proposed by some studies to be a promising approach for preventing AKI in these instances, although the strength of data available is still considered insufficient.

What about in cases of intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS)?

Michael Joannidis: Prevention of IAH is of high relevance, with effective measures consisting of limiting positive fluid balance and ensuring gut function by applying early enteral nutrition (EN). In the case of ACS surgical intervention may be unavoidable.

Should we use crystalloids or colloids for fluid resuscitation?

Michael Joannidis: Currently isotonic crystalloids are considered first choice for fluid resuscitation which is also reflected by recent recommendations of a task force of ESICM. This preference results from several recent publications indicating possible renal impairment by synthetic colloids, especially starches. The role of hyperoncotic albumin in critically ill patients is currently under investigation by two large RCTs.

What role do diuretics play in the management of acute kidney injury?

John Kellum: Diuretics should only be used to treat or avoid volume overload; they are not treatments for AKI per se and offer no benefit to the kidney. In fact, data-form observational studies suggest harmful risks exist in the use of diuretics, causing some clinicians to favour using extracorporeal therapy for managing fluid and solute in patients with AKI. Still, diuretics will remain an irreplaceable tool for management of volume in critically ill patients with and without AKI.

What is the role of renal replacement therapy (RRT) in the management of acute kidney injury?

John Kellum: Emerging evidence suggests that early RRT leads to better outcomes for patients with severe AKI. The difficulty lies in deciding which patients will ultimately require RRT and which will experience rapid spontaneous recovery. AKI biomarkers may play a role in this process. Another question is that of modality. CRRT is gentle and unlikely to result in further insult to a injured kidney, whereas intermittent haemodialysis has the potential to cause further damage. Based on current evidence, we recommend initiating RRT prior

Table 1. A comparison of the RIFLE and AKIN definition and classification schemes for AKI (Taken from Bagshaw et al. (2008))

RIFLE category	Serum creatinine criteria	UO criteria
(A) The Acute Dialysis Quality Initiative (ADQI) criteria for the definition and classification of AKI (i.e.RIFLE criteria)		
Risk	Increase in serum creatinine ≥ 1.5X baseline or decrease in GFR ≥ 25%	< 0.5 mL/kg/h for ≥ 6 h
Injury	Increase in serum creatinine ≥ 2.0X baseline or decrease in GFR ≥ 50%	< 0.5 mL/kg/h for ≥ 12 h
Failure	Increase in serum creatinine ≥ 3.0X baseline or decrease in GFR ≥ 75% or an absolute serum creatinine ≥ 354 µmol/L with an acute rise of at least 44 µmol/L	< 0.3 mL/kg/h for ≥ 24 h or anuria ≥ 12 h
AKIN criteria	**Serum creatinine criteria**	
(B) The proposed Acute Kidney Injury Network (AKIN) criteria for the definition and classification of AKI		
Stage 1	Increase in serum creatinine ≥ 26.2 µmol/L or increase to ≥ 150-199% (1.5-to 1.9- fold) from baseline	< 0.5 mL/kg/h for ≥ 6 h
Stage 2	Increase in serum creatinine to ≥ 200-299% (> 2-2.9 fold) from baseline	< 0.5 mL/kg/h for ≥ 12 h
Stage 3	Increase in serum creatinine to ≥ 300% (≥ 3-fold) from baseline or serum creatinine ≥ 354 µmol/L with an acute rise of at least 44 µmol/L or initiation of RRT	< 0.3 mL/kg/h for ≥ 24 h or anuria ≥ 12 h

to complications such as volume overload and hyperkalaemia. In patients at risk for haemodynamic instability or intracranial hypertension we recommend using CRRT, while we also recommend CRRT when intermittent haemodialysis is insufficient to obtain adequate fluid and solute management.

How can the best starting time for RRT be determined?

Claudio Ronco: The issue of the appropriate start of extracorporeal techniques in the critically ill patient has long been debated by experts, consensus, organisations and evidence panels. The modern view is that an early application of extracorporeal techniques may provide benefits that prevail over the potential draw backs of futile exposure of a patient to unnecessary blood/artificial material contact. Benefits include the control of fluid balance, avoidance of severe derangements and prevention rather than correction of biochemical and clinical disorders.

Recently, techniques and related equipment have become so simple and user-friendly that no application of an extracorporeal therapy, even in critically ill patients, is seen as a risk, rather they are viewed as a promising opportunity. The classic indications represented by oliguria, azotaemia and other uremic complications are considered as extreme consequences of an inappropriate strategy of prevention and management. Furthermore, extracorporeal techniques are considered to be a method of support rather than a replacement of the failing organ. For this reason, indications for the initiation of treatment have changed and have become softer, justifying an early start.

Early versus late is a terminology that may become complex and misleading unless we define exactly a reference parameter, since different meanings are construed from these terms depending on creatinine, urine output or other biochemical parameters used. We advocate that the introduction of RIFLE/AKIN AKI stages has brought about a new dimension in response to this problem. We now have fixed criteria to define AKI and to stage it. A new option has become available thanks to early AKI biomarkers such as NGAL, Cystatin C and KIM-1, and the diagnosis of AKI may be possible today even in the absence of oliguria or a rise in serum creatinine. The biomarker positive patient without creatinine or urine output abnormalities has been shown to have a worse prognosis and more severe outcome; thus, the entire concept of early should be revisited in light of these recent acquisitions.

Finally, it should be noted that if an early start of RRT is applied, we might end up treating patients who would have improved anyway, or in which the treatment is futile and unecessarily costly. Clinical trials so far conducted seem to rule against this hypothesis, although a solid body of evidence is still missing. Our clinical experience conveys that every patient is a self standing case and we should carefully evaluate the patient with a multidisciplinary approach to decide on the best start time for RRT.

Which types of patients would best benefit from continuous renal replacement therapy (CRRT) and which from intermittent haemodialysis (IHD)?

Claudio Ronco: First of all we must say that CRRT and IHD are not opposite therapies but rather two schedules of the same treatment in a continuum that goes from short intermittent sessions to continuous 24/7 treatments. For this reason, one patient may shift from one schedule to another during his/her hospital stay.

In general, we may say that due to the characteristics of each schedule, patients with haemodynamic instability, at risk for brain oedema and/or presenting signs and symptoms of severe sepsis and septic shock, are most likely to find benefits from continuous therapies. On the other hand, patients that are haemodynamically stable or that are moving from a severe illness to a less severe clinical condition with improved haemodynamics may benefit from a discontinuation of CRRT, receiving occasional sessions of isolated haemodialysis/haemofiltration.

Several debates and controversies exist regarding CRRT versus IHD, as there is no compromise or intermediate approach. However, studies comparing continuous and intermittent therapies have failed to demonstrate the superiority of one schedule against the other. Today critically ill patients admitted to ICU are most likely to receive CRRT whilst patients with isolated AKI, outside ICU, are most likely to receive a daily or thrice weekly schedule of intermittent IHD.

What changes do you foresee in the treatment of AKI in the coming decade?

John Kellum: The near future is likely to see greater use of AKI biomarkers for risk assessment. Also, increased recognition of AKI, bolstered in large part by the many consensus documents being published, will result in better care and increased research. The results will hopefully be the development of novel therapies designed to attenuate renal injury and/or facilitate renal recovery. Finally, we anticipate additional studies to settle the issue of when to initiate RRT.

Which emerging technologies in the field excite you the most?

John Kellum: Therapies targeted at blocking inflammation in the kidney rather than manipulating the circulation interest me a lot. Also fascinating is the emergence of better forms of blood purification with the ability to remove molecules that perpetuate damage in the kidney.

Claudio Ronco: What excites me the most is Multiple Organ Support Therapy (MOST). New CRRT platforms have the capability to process blood in a series of extracorporeal circuits and devices that allow for renal, liver, cardiac and pulmonary support. The capacity to simultaneously remove uremic waste products and CO_2, combining renal and pulmonary support, is opening new interesting avenues in the care of critically ill patients. By adding adsorption devices capable of removing endotoxin and septic mediators, one can really achieve a universal treatment for organ support in critical illness and sepsis. Studies should be designed to test the effects of such new therapies on solid endpoints in well-designed clinical trials. ■

References

Bagshaw R et al. (2008). A comparison of the RIFLE and AKIN criteria for acute kidney injury in critically ill patients. Nephrol Dial Transplant, 23:1569–1574.

Kidney Disease: Improving Global Outcomes (KDIGO) (2012). KDIGO Clinical Practice Guideline for Acute Kidney Injury. Kidney International

PAST AND PRESENT
CHALLENGES IN ICU MANAGEMENT

Jukka Takala, *MD, PhD*

Professor of Intensive Care Medicine
Director
Department of Intensive Care Medicine
Bern University Hospital and University of Bern
Bern, Switzerland

jukka.takala@insel.ch

Introduction

Maintaining an intensive care unit (ICU) and providing intensive care for all patients who benefit from it necessitates a high investment in personnel, technology, and material resources within a short time period, and is naturally associated with costs. The complexity of the care processes involved, and the fluctuation in the number of patients needing intensive care at a specific time, make managing intensive care resources very challenging. Having too many resources can be notoriously expensive and can lead to an inappropriate use of ICU beds, while having too few ICU resources prevents timely admission of patients, increases the risk of poor outcomes, and may paradoxically increase costs by unnecessarily prolonging patients' stay in the ICU. Optimising the whole patient care process—including the pre-ICU, ICU, and post-ICU phases—has the greatest potential for efficient resource use and improved outcomes.

Lessons from the Past

The challenges of ICU management are nothing new. The whole principle of concentrating care personnel and cohorting the sickest patients in one area for more intensive monitoring and care was established over centuries of treating the casualties of wars, epidemics, and natural catastrophes.

The care of patients during polio epidemics in the 1950's in Copenhagen, often referred to as the birth of modern intensive care, was a masterpiece of care process optimisation, organisation and management. Clinical observations suggesting hypoventilation as the cause of patient deterioration were confirmed and the problem was treated using a new application of available technology (combination of tracheostomy with prolonged manual ventilation). A therapeutic strategy was then developed for large-scale use of such treatment, and associated decision-makers were convinced to provide the necessary resources. Furthermore, a multidisciplinary team and the logistics necessary for long-term treatment of large numbers of patients were introduced. Finally, quality assurance was undertaken by assessing the outcomes of this care process.

The subsequent proliferation of ICUs in Europe, North America, and Australasia further revealed the complexity of ICU management. A report from National Academy of Sciences – National Research Council Committee on Anesthesia: Workshop on Intensive Care Units, which was held on 14 October, 1963, in Washington, DC, summarises many problems that are still very relevant (Hamilton 1964). The following provides a brief overview and summary of this report, which can be considered a seminal paper on ICU management.

National Academy of Sciences – National Research Council Committee on Anesthesia: Workshop on Intensive Care Units

In the decade following the polio epidemics, many surgical, medical, and respiratory ICUs had been opened, and the pioneers in the new specialty area faced many novel challenges. Patient management-related themes were heavily focused on treatment of respiratory failure (airway management, humidification, recognition and management of respiratory insufficiency), thus reflecting the major and dramatic achievements during the decade after the polio epidemics. Other clinical themes included characterisation of patient populations in the various participating ICUs (case mix) and infection control—both still very current today. The main management themes discussed included architecture and design of ICUs, organisation, staffing, and training of doctors and nurses.

Many of the contributors were already, or were soon to become, established and renowned scientists in areas that would play a role in the future of intensive care medicine, but in the aforementioned workshop it was their insight into organisational and administrative issues that was most impressive. From today's perspective, it is fascinating to note that those early pioneers pointed out most of the problems related to intensive care that remain challenging or unsolved still today, almost half a century later: the role of different specialties in the treatment of a patient with multidisciplinary problems; the need for specialty training for both nurses and doctors; the need for attending specialists to be directly involved in and responsible for patient care. In the words of Dr. D Bates from Royal Victoria Hospital, Montreal: "The main responsibility for cases should, I believe, rest with attending staff, since no resident who has not had special training in this discipline is capable of taking care of these cases." Dr. J Severinghaus, University of California Medical Center at San Francisco, who is best known for his decades-long contributions to our understanding of respiratory and blood gas physiology, addressed the question of who holds ultimate responsibility for admitting and taking care of patients in ICUs, and who is responsible for the general administration of intensive care: an organisational issue still very current today.

Dr. J Kinney, at the time a surgeon at the Peter Bent Brigham Hospital in Boston and a

future pioneer in metabolic research in the critically ill at Columbia Presbyterian Medical Center, New York, pointed out that no single physician can cover a critically ill patient 24 hours a day for five to six days, a typical average length of stay in many units then (and now), necessitating that responsibility be shared—a very simple fact still denied in many hospitals today. It was recognised that an interdisciplinary team approach with defined leadership was necessary, although some participants questioned this, favouring that referring physicians have privileges to use intensive care facilities—the still continuing debate over 'closed' vs. 'open' intensive care units. Dr. P Safar, the developer of cardiopulmonary resuscitation as we know it today, strongly advocated an interdisciplinary, 'closed' model.

Safar presented a comprehensive review of his concepts of intensive care, based on his experience in setting up intensive care services first in Baltimore in 1958, and subsequently in the Presbyterian-University Hospital in Pittsburgh, starting in 1961. In Pittsburgh, an interdisciplinary subcommittee was formed for intensive care. It consisted of representatives from surgery, medicine, infectious diseases, neurosurgery, nursing, administration, and anesthesia, with the chief of anesthesia as chairman. The Intensive Care Unit Policy summarised the purpose, admission and discharge concepts; triage in the case of lack of resources; patient assignment to a single responsible service; ordering concepts, consultations, definition and use of guidelines and protocols for various procedures and aspects of care; training; and delegation of selected complex tasks to highly trained nursing staff. Dr. Safar summarised the prerequisites for smooth functioning of intensive care as interdepartmental cooperation, well-defined responsibilities and authority, and the physical set-up and standardisation of certain procedures—all principles applicable today as well. Moreover, Dr. H Pontoppidan, another acute respiratory failure specialist, presented an ICU patient classification system based on the level of care needed.

Past and Present

Management and organisational solutions in intensive care medicine have without a doubt matured. Many ideas and principles of organisation, structure, leadership, and training that were formulated in the 1950's and 1960's have been institutionalised, and intensive care medicine has established itself among other specialties, with fights over ownership belonging in the past. One important lesson is that competency-based training programmes are the way to develop open access to intensive care medicine.

In 1973 Dr. W Shoemaker wrote a summary of the principles necessary for organising and managing intensive care medicine, which are still very valid today: "Traditionally, complicated cases are handled by calling for consultations. When the complications are few and they appear in staggered fashion, this approach may function reasonably well. But management of the critically ill patient with multiple vital organ failures often requires maximum coordination of a wide range of professional activities and close monitoring of the patient's course. This can best be attained in a multidisciplinary ICU where the maximum input of specialties may be coordinated with continuous surveillance and laboratory support. The patient with multiple injuries and the acutely ill patient with multiple vital organ failure have many common physiologic problems. As the same therapeutic modalities are used, the multidisciplinary team approach is optimally suited to coordinate therapy for multiple organ failure." ■

References

Hamilton, WK. National Academy of Sciences—National Research Council Committee on Anesthesia: Workshop on intensive care units, Anesthesiology, 1964 25(2):192-222.
Shoemaker, WC. Multiple injuries and multiple organ failure, Crit Care Med, 19731(3):157

Continues from page 35

elements have to be accommodated.

Data from the laboratory (bloodstream infections) and the tally of central lines were used to determine two key measures:

- The CLAB rate per 1,000 line days; and
- The number of days between CLAB cases.

Results and Discussion

In 2008, before the CLAB initiative started, the ICU had 14 patients with CLAB, a median of 28.1 days (SD 2.1) between cases and a rate of 6.8/1,000 line days (see Table 1). Despite the increased bed numbers and workload in 2009, there were only four cases of CLAB, the median days between cases increased to 75.8 and the CLAB rate dropped to 3.0 CLAB/1,000 line days. In the first six months of 2010, the rate had dropped to 0.9 CLAB/1,000 line days.

With a multifaceted quality improvement programme and good clinical leadership, the team at Middlemore Hospital's Critical Care Complex was able to reduce CLAB rates from 6.8 to 0.9/1,000 line days in 18 months.

Although we have undergone many months without a CLAB in the last year, we did have a cluster of five CLABs in a month and a half, so our rate over the last six months has risen accordingly (2.0/1,000 line days). The team did a full investigation of the five CLAB cases and found that most were high-risk patients but had not been recognised as such, and that line maintenance compliance had fallen from 80-90% to 40-50%. This was not apparent to staff at the time because we were only plotting monthly compliance rates. As a consequence, weekly rates were charted from then on, and senior charge nurses were asked to check compliance at the end of every shift. Following these changes, compliance improved and CLAB cases ceased. However, it should be pointed out that with any quality improvement programme, holding the gains requires vigilance.

We have found that this CLAB prevention work has had a positive effect on the patient safety culture of the unit. Staff are now working on a number of other initiatives, including ventilator-associated pneumonia, improved handovers and

A full review of this study is available in the New Zealand Medical Journal (Seddon et al. 2011).

References

For references please send a request to **editorial@icu-management.org**

AUTHOR GUIDELINES

ICU MANAGEMENT

Content

Articles may focus on any management or practice issue in intensive care related to economics, quality of care or patient outcome. We only accept scientific papers with a clear connection to management and practise issues. We also invite opinions for publication in our Viewpoints section, which can be personal opinions of the author and/or reactions to articles published in prior issues. These are published at the discretion of the editors. Submissions may not have been published previously or be currently submitted for publication elsewhere. Articles must be written by independent authorities and any sponsors for research must be named. If manufacturers are named in an article, the text must present an unbiased view, not in support of any particular company.

Submission Guidelines

Authors are responsible for all statements made in their work, including changes made by the editor and authorised by the submitting author. The text should be provided as a word document via email to editorial@icu-management.org. Please provide a contact email address for correspondence. Following review, a revised version, which includes the editors' comments and recommendations, is returned to the author (at the contact email address) for authorisation.

Length

- Articles: maximum 1400 words (less if figures or tables are included)
- Viewpoints: maximum 700 words
- News/research/product updates: maximum 200 words

Please note that contributions longer than the specified number of words may not be accepted.

Structure

Article texts must contain:

- Title
- Names of authors with abbreviations for the highest academic degree
- Affiliation: Department and institution, city and country
- Main authors are requested to supply a portrait photo (see specifications below)
- Summary of one or two sentences (no more than 30 words) describing the content
- Contact name for correspondence and an email address which may be published with the article
- Website, if appropriate
- Acknowledgements of any connections with a company or financial sponsor
- Introduction, main text and summary/conclusion, with subheadings as appropriate
- Authors are encouraged to include checklists and/or guidelines, which summarise findings or recommendations
- References or sources, if appropriate, as specified below

Writing Style

Articles must be written in UK/British English (e.g. organisation, not organization), with short sentences, a clear structure (see above) and no bias. Full stops in numbers may only be used to indicate a decimal place; otherwise use commas as separators.

Images

Main authors are asked to supply a portrait photo for publication with their article. This and any other relevant images for publication with an article should be sent by email as separate files (only high resolution images with 300dpi) and their order of placement in the article must be clearly indicated. Only the electronic formats ".tif" or ".jpg" can be used for images, i.e. not Microsoft Word or PowerPoint. Images must be no smaller than 9cm x 9cm at 100% scale. Only images meeting these specifications can be published. If an image has been published before, permission to reproduce the material must be obtained by the author from the copyright holder and the original source acknowledged in the text, e.g. © 2012 Marianna Keen.

Format for References

Any references that are deemed important to understanding of the article should be cited in concise form within the article. Please use the Harvard reference system. Citations within the text for a single author reference should include the author surname and year of publication; for a citation with two authors include both author surnames and year of publication; for more than two authors, include the first author surname followed by "et al." and the year of publication. Multiple citations should be separated by a semicolon, and listed in alphabetical order.

Example of within text citation: (Edwards 2004; Edwards and Miller 2002; Miller et al. 2003).

Reference lists should be alphabetised by lead author and included at the conclusion of the submission.

Example of standard journal reference: Sydow Campbell, K. (1999) "Collecting information; qualitative research methods for solving workplace problems", Technical communication, 46 (4) 532-544.

Authors are responsible for the accuracy of the references they cite.

Acceptance

It is always at the discretion of our editorial board to accept or refuse submissions. We will respond to submissions within 8 weeks of receipt. We reserve the right to revise the article or request the author to edit the contents, and to publish all texts in any MindByte Communications journal, on the Internet and to list them in online literature databases.

Thank you,
The ICU Management Editorial Team
editorial@icu-management.org

DUTCH INTENSIVE CARE MEDICINE: ITS START, PROFESSIONALISM AND FUTURE PROSPECTS

Peter de Feiter, *MD*
President, NVIC
Department of Intensive Care Medicine
Sint Fransiscus Gasthuis
Rotterdam, the Netherlands

Ilse van Stijn, *MD*
Secretary of the Board, NVIC
Department of Intensive Care Medicine
Onze Lieve Vrouwe Gasthuis
Amsterdam, the Netherlands

David Dongelmans, *MD, PhD*
Member of the Board, NVIC
Department of Intensive Care Medicine
Academic Medical Center
Amsterdam, the Netherlands

The Dutch Society of Intensive Care celebrates its 35th anniversary this year, prompting this overview of developments in intensive care medicine within the Netherlands and the society known as Nederlandse Vereniging voor Intensive Care (NVIC), looking at eras of evolution and innovation, as well as assessing what the future holds.

The Emergence of Intensive Care Medicine in the 1950's and the Role of Polio-Epidemics.

In the Netherlands, as in may other countries, the 1955 polio-epidemic stimulated the organisation of treatment of patients suffering from respiratory failure. Before the epidemic, patients suffering from poliomyelitis were treated with respiratory support on an incidental basis.

In the university hospitals of Groningen, Utrecht, Amsterdam and Rotterdam, respiratory care units were established after the 1950's outbreak of polio, with input coming from anaesthesiologists, neurologists, pulmonologists and physiologists. In later years these units developed into respiratory care units for the treatment of patients developing respiratory failure resulting from other causes like sepsis, drowning, intoxications and post-resuscitation. The units progressed into intensive care units (ICU) for the treatment of patients with vital organ dysfunctions originating from medical disciplines. At the same time surgical intensive care medicine developed rapidly, impelled by expanding possibilities in cardiac- and cardio-pulmonary bypass surgery.

Cardiac surgery using heart-lung machines was started in the university hospital in Groningen in 1957, by van der Heide, a cardiac surgeon, and Dorlas, an anaesthesiologist. After cardiac surgery, patients were treated in the intensive treatment unit by attending anaesthesiologists. After the first coronary bypass procedure, in March, 1968, cardiac surgery continued to develop at a rapid pace, booming in the seventies and eighties as in many other countries.

By the beginning of the 70's nearly every surgical discipline had expanded its possibilities, mainly due to developments made in anaesthesia and postoperative intensive care. In these days the number of potential intensive care patients increased more rapidly than the available number of ICU beds. This steep increase in the need for intensive care facilities in all university hospitals and major non-university teaching hospitals necessitated the development of organisational formats for intensive care medicine. Also,

> *"The current course contains a two year adjuvant ICU training module as a subspecialty for medical specialists in anaesthesiology, internal medicine, pulmonology, surgery, cardiology and neurology"*

Statistics:

Total Population	16,485,787
Life expectancy at birth m/f (in good health)	79/82
Number of deaths (2010)	136, 058
Percentage of the population admitted to hospital	6.7
Percentage of the population in (very) good health	81.5
Supply of medical specialists	19,046
Expenditure on providers of care as % of GDP (2010)	14.8

Figures are for 2009 unless otherwise indicated
Source:
Statistics Netherlands
www.cbs.nl

the need for training of specialised IC-nurses and doctors became clear. At the end of 1979, a postgraduate programme in intensive care medicine for anaesthesiologists was developed by Dr. dos Reis Miranda Sr. in Groningen. Later, the first official training for anaesthesiologists by means of a fellowship in intensive care medicine was started in the Onze Lieve Vrouwe Gasthuis in Amsterdam by Dr. Zandstra.

The increase in motorisation in the 70's resulted in an increase in trauma patients, and the need for further intensive care treatment facilities increased once more, including a wider need for intensive care beds. Furthermore, several university hospitals started with organ transplant programmes, so yet more emergency and elective patients were competing for the limited number of available beds. These developments urged the need to further professionalise intensive care management as well as the organisation of the professionals working in the field of intensive care medicine. As a consequence, professional recognition, scientific accountability, and more uniform defined training developed in this period.

Already in the 60's, anaesthesiologists started to work as full-time intensive care doctors in postoperative intensive treatment units. At the end of the 70's, medical directors of intensive care units and formal staffs of intensivists were appointed.

As a sign of further professionalisation, the NVIC was founded in 1977 by Prof. Dr. Bruining and Prof. Dr.Thijs. From the start the primary goal of the NVIC was to stimulate professionalisation of intensive care medicine in the Netherlands. With the development of the medical arena, there was a growing field of research, and as a consequence, a claim on academic positions. Prof. Dr. Thijs was appointed the first extraordinary professor in acute internal medicine and 'de facto' intensive care medicine at the Free University in Amsterdam in 1987. In the same year, Prof. Dr. Bruining was appointed as extraordinary professor in surgical intensive care at the Erasmus University in Rotterdam.

Since several different disciplines such as anaesthesiology, surgery and internal medicine became involved in intensive care medicine, an initiative to combine these efforts was founded. The Gemeenschappelijke Intensivisten Commissie (GIC), the Dutch intensive care college, was founded in 1991 by representatives of the Dutch Society for Anaesthesiology, the Dutch Surgical Society, the Dutch Society of Internal Medicine and the Dutch Society of Intensive Care. The GIC was founded to create a college responsible for registration, training and advisory tasks, and consisted of intensivists originating from the different societies mentioned above.

The first president of the GIC was Prof. Dr. van der Linden with Dr. Stoutenbeek as the first secretary. In 1995 the Dutch Society of Neurology joined the GIC, followed by the Dutch Society for Cardiology in 1999, the Dutch Neurosurgical Society in 2001 and the Dutch Society for Pulmonology and Tuberculosis in 2002. The task of the college is to advise the societies in matters of registration and to formulate the training programme in intensive care medicine. Furthermore, the societies provided the GIC with the mandate to audit training centres and to create the national theoretical training programme; the so called GIC days. This GIC programme has been organised for all specialists in training from the Dutch training ICU's once every month ever since its establishment in 1995. The current course contains a two year adjuvant ICU training module as a subspecialty for medical specialists in anaesthesiology, internal medicine, pulmonology, surgery, cardiology and neurology. The training is formally ended by participating in the European Intensive Care Diploma examination.

Table 1. Presidents of Nederlandse Vereniging voor Intensive Care (NVIC)

Period	President	Secretary
1977-1982	Prof. Dr. Thijs	
1982-1986	Dr. van Kesteren	
1986-1991	Prof. Dr. van der Linden	Dr. van Hulstaert
1991-1994	Prof. Dr. Thijs	Prof. Dr. Bruining
1995-1997	Prof. Dr.Bruining	
1997-2001	Prof. Dr. Bakker	Toet
2001-2003	van Leeuwen	Dr. van Zanten
2003-2006	Prof. Dr. van der Hoeven	Dr. van Zanten
2006-2010	van der Spoel	Meeder/ van Stijn
2010-present	de Feiter	van Stijn

The Nederlandse Vereniging voor Intensive Care

In 1993 Inca, a foundation of young doctors in intensive care medicine, with a primary focus on education in intensive care medicine, was founded, and in 1997 the decision was made for it to join forces with the NVIC. Intensivisten Vereniging Nederland also later merged with the NVIC and from that day forward the NVIC has been the only Dutch Society in Intensive Care. Since it was founded in 1977, the NVIC has had many presidents, as seen in Table 1.

The primary objectives of the NVIC are:

- To promote intensive care medicine;
- To stand up for the interests of the intensive care patient by stimulating improvement of effective, patient orientated and successful treatment of ICU patients and stimulating further development and professionalisation in intensive care medicine and organisation;
- To represent all intensivists in the Netherlands and stand up for their interests;
- To define and implement current and future policies in respect of intensive care medicine and organisation in the Netherlands;
- To stimulate the progression of quality in intensive care medicine and monitoring; and
- To augment the knowledge area of intensive care by stimulating research.

Currently, the NVIC has over 1,200 members. As mentioned above, one of its goals is to increase professionalisation in intensive care. Another important objective is educa-

tion. From the point of view of the NVIC, the patient holds the central role; every patient in need of intensive care treatment should receive this care in a timely and adequate fashion. In order to facilitate intensive care departments and intensivists in the Netherlands, the NVIC has published several national guidelines. The spectrum of these guidelines is broad; they cover medical treatment as well as organisational aspects. A part of the guidelines is multidisciplinary, developed together with other societies. For example, the treatment of Guillain Barre syndrome is a project by the Society of Neurology together with the Dutch Society of Intensive Care.

Besides the development of guidelines, the NVIC gives high priority to training and congresses; hence, it organises congresses and training sessions for young doctors and post-graduates. In addition to the annual congress, The Intensivistsdays, the NVIC organises a large number of thematic courses. As well as providing the fundamental critical care support (FCCS) course, it runs classes in mechanical ventilation, infection in the ICU, circulation in the intensive care patient, neurology, renal, liver and bowel issues in intensive care medicine, echography as well as trauma and acute medicine. The programme of the Intensivistsdays is composed of state of the art lectures, lectures about PhD theses in the field of intensive care medicine, educational sessions and the presentation of research. The best PhD thesis in the field of intensive care medicine is rewarded with an annual thesis award. The accreditation committee of the NVIC assesses all intensive care congresses for accreditation.

> *"From the start the primary goal of the NVIC was to stimulate professionalisation of intensive care medicine in the Netherlands"*

Another important issue for the NVIC is the monitoring of the quality of intensive care departments; thus, the national quality audit committee (NKIC) audits a number of ICU departments every year. The guideline establishment, Organisation and practices in ICU departments for adults in the Netherlands (NVA 2006), forms the basis for these audits. This guideline gave an enormous impulse in further professionalisation, mainly through the formalisation of nursing staff and medical staff on every intensive care department, as well as the formalisation of the position of the ICU in the hospital, resulting in higher quality standards. At this moment a committee is working on the revision of this important guideline. As in many countries, not all intensive care departments in the Netherlands have the same expertise. In order to treat every intensive care patient adequately for his/her particular illness, with the modalities needed, ICUs have to work together within the (geographical) region. To enumerate interregional collaborations and to offer a helping hand, the NVIC started the Samenwerken In de REgio (SIRE) project, resulting in many reccommendations.

Another role for the NVIC is to convene with all forums in the Netherlands, which, in the broadest sense, play a role in intensive care medicine. Parties with whom the NVIC is in contact are the Ministry of Health, The Dutch Healthcare Inspectorate, the European Society of Intensive Care Medicine (ESICM), the Dutch authority of finance in the Healthsector, among others.

The activities of the NVIC are extensive, and could not be done without the work of NVIC committee members (Table 2). Thus, on this 35th anniversary of The Dutch Society of Intensive Care, Peter de Feiter, president, NVIC, expressed to ICU Management his gratitude to all those involved: "We would like to take this opportunity to thank all our committee members for their efforts towards the NVIC and our shared goals. Together we are bringing intensive care to an ever higher level." ■

Table 2. NVIC Committees

Committee	President
Editorial board NJCC	Prof. Dr. Groeneveld
NKIC (audit)	Prof. Dr. Girbes
Congress	Prof. Dr. Groeneveld
Development of guidelines	Dr. Tepaske
Quality and safety	Dr. van Zanten
Accreditation	de Waal
Ethics	Gerritsen
Complication registration	Dr. Arbous
Transport	van Lieshout
FCCS	Schuitemaker
Indicators	Dr. van der Voort
Finance	de Feiter
Echography	Blans
SIRE	Dr. Versluis
Neuro-intensive care	Dr. Kuiper
Farmacotherapeutics	Prof. Dr. Girbes
Intensivist in training committee	Tuinman
After IC care	van der Steen
Medium care	Tjan
Netherlands Critical Care Trials Group	Dr. Gommers
Nephrology	Dr. Oudemans-van Straaten

European Society of Anaesthesiology

ESA

Paris, France

Euroanaesthesia 2012

The European Anaesthesiology Congress

June 9-12

Symposia
Refresher Courses
Workshops
Industrial Symposia & Exhibition
Abstract Presentations

CME Accreditation
EACCME - UEMS

Deadline abstracts:
December 15th 2011
Online submission:
www.euroanaesthesia.org

ESA Secretariat
Phone +32 (0)2 743 32 90
Fax +32 (0)2 743 32 98
E-mail: registration@euroanaesthesia.org

AGENDA

APRIL

5-7 Emirates Critical Care Conference
Dubai, United Arab Emirates
www.eics.ae

MAY

18-23 American Thoracic Society (ATS) International Conference
San Fransisco, California
www.thoracic.org

24-25 ESICM Summer Conference - Trauma Update 2012
London, UK
www.esicm.org

31-2 Advance Care Planning and End of Life Care Conference 2012
Chicago, USA
www.acpelsociety.com

JUNE

7-9 2nd International Congress: Anesthesia for Seniors
Prague, Czech Republic
www.anesthesiaforseniors2012.cz

7-9 Chilling at the Beach - 2nd Innsbruck Hypothermia Symposium
Portoroz, Slovenia
http://chilling-at-the-beach.eu

9-12 Euroanaesthesia 2012
Paris, France
www.euroanesthesia.org

12-15 30th Anniversary International Vicenza Course on Peritoneal Dialysis
Vicenza, Italy
http://www.vicenzanephrocourses.com

OCTOBER

13-17 25th ESICM LIVES 2012 Annual Congress
Lisbon, Portugal
www.esicm.org

NOVEMBER

17 2nd International Fluid Academy Day
Antwerp, Belgium
www.fluid-academy.org

In our Next Issue

COVER STORY
Education

COUNTRY FOCUS
Russia

MATRIX
Fluid Management (2)
ICU Sedation

MANAGEMENT
How to Get a Grant?

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

ICU Management is the Official Management and Practice Journal of the International Symposium on Intensive Care and Emergency Medicine.

EDITOR-IN CHIEF
Jean-Louis Vincent, Head, Department of Intensive Care, Erasme Hospital, Free University of Brussels, Belgium jlvincen@ulb.ac.be

EDITORIAL BOARD
Prof. Antonio Artigas (Spain) aartigas@cspt.es
Dr. Richard Beale (United Kingdom) richard.beale@gstt.sthames.nhs.uk
Prof. Julian Bion (United Kingdom) j.f.bion@bham.ac.uk
Dr. Todd Dorman (United States) tdorman@jhmi.edu
Prof. Hans Kristian Flaatten (Norway) hans.flaatten@helse-bergen.no
Prof. Luciano Gattinoni (Italy) gattinon@policlinico.mi.it
Prof. Armand Girbes (Netherlands) arj.girbes@vumc.nl
Prof. Jeff Lipman (Australia) j.lipman@uq.edu.au
Prof. Konrad Reinhart (Germany) konrad.reinhart@med.uni-jena.de
Prof. Paolo Pelosi (Italy) ppelosi@hotmail.com
Prof. Peter Pronovost (United States) ppronovo@jhmi.edu
Prof. Jukka Takala (Switzerland) jukka.takala@insel.ch

NATIONAL CORRESPONDENTS
Dr. Maurizia Capuzzo (Italy) cpm@unife.it
Nathalie Danjoux (Canada) nathalie.danjoux@uhn.on.ca
Prof. David Edbrooke (United Kingdom) davidedbrooke117@btinternet.com
Prof. Dr. Dominique Vandijck (Belgium) dominique.vandijck@ugent.be

MANAGING EDITOR
Marianna Keen editorial@icu-management.org

SCIENTIFIC EDITOR
Dr. Sonya Miller science@icu-management.org

EDITORS
Lee Campbell, Dervla Gleeson

EUROPEAN AFFAIRS EDITOR
Sonja Planitzer

GUEST AUTHORS
Mette M. Berger, Elena C. Capello, Ken Catchpole, Mélanie Charrière, Andrew Davies, Peter de Feiter, David Dongelmans, Gianpaolo Fusari, Jenny Gualino, Daren Heyland, Michael Joannidis, John Kellum, Jozef Kesecioglu, Manu Malbrain, Ed Matthews, Lauren Murch, Ibolya Nyulasi, Fabrizio Racca, V. Marco Ranieri, Emma Ridley, Claudio Ronco, Mary E Seddon, Margriet M.E. Schneider, Ludivine Soguel, Jukka Takala, Audrey Tierney, Niels Van Regenmortel, Ilse van Stijn

ICU MANAGEMENT IS PUBLISHED BY
MindBYTE Communications Ltd
9, Vassili Michailidi CY-3026 Limassol, Cyprus
E-mail: office@icu-management.org
Website: www.icu-management.org

PUBLISHER AND CEO
Christian Marolt c.m@icu-management.org

MEDIA CONTACT, MARKETING, ADVERTISING
Katya Mitreva k.m@icu-management.org

SUBSCRIPTION RATES

One year	Europe	53 Euros
	Overseas	68 Euros
Two years	Europe	89 Euros
	Overseas	105 Euros

Note: Participants of the International Symposium on Intensive Care and Emergency Medicine receive a one year subscription as part of their symposium fee.

ART DIRECTOR
Tassos Kostis art1@mindbyte.eu

PRODUCTION AND PRINTING
Total circulation: 8,450
ISSN = 1377-7564

REFERENCES
References cited in this journal are provided to ICU Management by the authors and are available on request at editorial@icu-management.org.

AMERICAN THORACIC SOCIETY **INTERNATIONAL CONFERENCE**

ATS•2012 San Francisco

MAY 18-23

Where today's science meets tomorrow's care™

A Selection of Clinical & Scientific Sessions

- Microparticles: Small Wonders or a Big Deal in Pulmonary Injury & Disease?
- An Ounce of Prevention in Critical Care
- Extracorporeal Gas Exchange: Respiratory Failure & Beyond
- Acute Kidney Injury in the ICU
- Using Genomics to Understand & Treat ALI
- Quality & Performance Measures: The Future of Healthcare
- Intensive Care of the Future
- Critical Care in the Immunocompromised Host
- Year in Reviews: Ethics & End of Life Care
- Pro-Con Debate on CER: Fool's Gold or Promised Land?
- Clinical Impact of Point of Care Ultrasonography in Critically Ill Patients+
- ICU Monitoring*

*Postgraduate course
+Workshop

"The great strength of the ATS International Conference is that scientists and clinicians—some of the best in the field—present findings and discuss clinical issues side by side."
–Imad Haddad, MD

"The conference helps clinicians better understand the evolution of the most advanced treatments. Attendees hear from the investigators themselves—from the scientists who performed the first studies to the clinicians who are applying those ideas to patient care."
–Karen A. Fagan, MD

No other meeting provides as much information about how the science of respiratory, critical care and sleep medicine is changing clinical practice.

SET YOUR FOCUS: With more than 500 sessions, 800 speakers and 5,800 original scientific research abstracts and case reports, ATS 2012 offers attendees a broad spectrum of topics so that they can learn about developments in many fields, or concentrate on the latest findings in ARDS, ICU monitoring, hospital-associated infections, ultrasonography, palliative care and sepsis.

LEARN FROM THE BEST: Outstanding researchers and clinicians will present their latest findings at symposia, year in review sessions and postgraduate courses. Experts will discuss issues related to critical care ethics, quality improvement in the ICU and the results from breaking clinical trials.

NETWORK: The ATS International Conference draws the most knowledgeable scientists and dedicated clinicians from around the world and provides a collegial environment for exchanging ideas.

Registration is now open.

www.thoracic.org/go/international-conference

ATS *We help the world breathe®*
PULMONARY • CRITICAL CARE • SLEEP

MAQUET
GETINGE GROUP

ADD A NEW RESPIRATORY STRATEGY
PUMP ASSISTED LUNG PROTECTION

Join us at ISICEM 2012: PALP – Pump Assisted Lung Protection – stands for early initiation of low flow extra-corporeal CO_2 removal. This CARDIOHELP therapy application can allow early discontinuation of invasive mechanical ventilation in acute hypercarbic respiratory failure, or can even help to prevent it.

MAQUET – The Gold Standard.

We cordially invite you to the symposium
"PALP – A New Experience in Lung Assist"
Chair: Mueller T., Ranieri M.
Speakers: Windisch W., Mueller T., Ranieri M.

Thursday 22nd March, 12:30 - 13:30, 100 Hall, ISICEM 2012

More information: www.maquet-cardiohelp.com

View the brochure:

MAQUET Cardiopulmonary AG | www.maquet.com