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Education

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Education

"The function of education is to teach one to think intensively and to think critically" Martin Luther King

Worldwide there is still much variation in type and duration of intensive care medicine training programmes (Amin et al. 2016). What is clear is that training programmes need to cover the 'basics' as well as adapt to accommodate new skills, such as point-of-care ultrasound. Education and training for the intensive care specialist are a lifelong commitment. Advances in communication methods and technology have enabled easier ways to keep our knowledge up to date, however.

Todd Dorman starts our cover story on Education by explaining four key adult education principles, which enable active teaching and learning so that the educator is facilitator and coach rather than the "sage on the stage". Next, Wai Tat Wong, Lowell Ling and Charles Gomersall outline the rationale for and lessons learned from the BASIC education collaboration for intensive care practitioners. BASIC courses have been held in 50 countries, and emphasise high-value small group instruction rather than low-value lecturing.

Caroline Hurd is interviewed about why palliative education for intensivists is needed and how it can be taught effectively. She emphasises that communication skills need to be treated and taught with the same importance as procedural skills. Next, Christopher Peter Nickson writes about the free open-access medical education movement—more than just social media, it is a useful adjunct to existing medical education with many benefits such as 'just-in-time' knowledge delivery.

As a prerequisite for a clinical rotation in the ICU, undergraduate physiotherapy students at the European School of Physiotherapy participate in an e-learning programme. Mel Major-Helsloot, Marike Van der Schaf, Bas Moed and Raoul Engelbert describe the development of the e-learning programme and its evaluation. It has proved to be a feasible way to provide students with the basic knowledge, skills and clinical reasoning required before they go into the ICU.

Next, Francesca Rubulotta and Pascale Gruber describe the vision behind and latest developments in the European Society of Intensive Care Medicine's Competency-Based Training in Intensive Care Medicine in Europe (CoBaTrICE), which aims to promote modernisation and mobility by providing a unified and harmonised model of training doctors caring for critically ill patients and their families around the world.

Last, Jessy Barré, Arthur Neuschwander and Antoine Tesniere outline the benefits of crew resource management (CRM) education for intensive care and emergency medicine specialists. Such simulation training has great advantages for assessing and improving non-technical or 'soft' skills, such as communication, situation awareness and decision-making, which are needed for teams working in the high pressure environments of intensive care and emergency medicine.

In the Matrix section, Benjamin Tang and colleagues evaluate recent advances in molecular testing for patients with suspected respiratory tract infection, and look to the future with combined use of virus detection assay and host response biomarkers.

In the management section, Alicia C. Dykstra and John J. Marini describe the successful integration of a nurse practitioner into the critical care team. They emphasise that the role is intended to augment the interdisciplinary team to meet genuine and unmet needs, rather than compete with the intensivist's role. The greatest benefit has been to provide continuity of care.

Next, Roland Burgers and Erik van Raaij explain an innovative purchasing portfolio model for intensive care centres, which allows managers to make the best decisions on use of scarce resources, including time spent with suppliers.

The health service in Wales, UK, set out to improve outcomes from sepsis and acute kidney injury. Chris Hancock and Adam Watkins describe the 1000 Lives Improvement Service Rapid Response to Acute Illness Learning Set (RRAILS) and the success factors that led to behaviour change across the healthcare system. In innovating to achieve behaviour change they note that it is vital that clinicians are given 'permission to act'.

Early mobilisation is important and beneficial for critically ill patients, yet often it is not implemented. David McWilliams explores how to overcome barriers, such as safety and ICU culture and structure—it's not as simple as increasing the dose or duration of therapy.

Next, Joyce A.M. Heijneman, Jasper van Bommel and Mathieu van der Jagt explain how they developed and implemented a process indicator and plan-do-check-act cycle aimed at improving intracranial pressure management of severe traumatic brain injury patients.

In our Interview section, Flavia Machado, talks about her work with the Latin America Sepsis Institute, quality improvement programmes for sepsis in Brazil as well as forthcoming research collaborations. Next, Maxime Cannesson looks to the future of technology in anaesthesia as well as the potential of the 'data mart' in perioperative care as a hub for data sharing in hospital.

As always, if you would like to get in touch, please email JLVincent@icu-management.org.

Jean-Louis Vincent

Reference

Amin P, Fox-Robichaud A, Divatia JV et al. (2016) The intensive care unit specialist: report from the task force of World Federation of Societies of Intensive and Critical Care Medicine. J Crit Care, 35: 223-8.

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IN EVERY ISSUE

POINT OF VIEW

COVER STORY

MATRIX

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MANAGEMENT

INTERVIEWS

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New member welcomed to Editorial Board

Dr. Francesca Rubulotta

ICU Management and Practice Editor-in-Chief, Prof. Jean-Louis Vincent is delighted to announce that Dr. Francesca Rubulotta has joined the Editorial Board. Dr. Rubulotta is Consultant and Honorary Senior Lecturer, Anaesthesia and Intensive Care Medicine at Imperial College, Charing Cross and St Mary's Hospital, NHS Trust London, UK. She qualified as MD at the University of Catania, Italy and trained in anaesthesia at the University of Trieste, Italy and in intensive care medicine at the Catholic University of Leuven in Belgium. She obtained her PhD at the University of Catania, Italy and has an executive Master in Business Administration from Imperial College London. In 2013-2016 Dr. Rubulotta was the Chair of the division of professional development (DPD) of the European Society of Intensive Care Medicine (ESICM) and is currently the Chair of the CoBaTrICE project. She was recently appointed as chair of the committee of medical managers of the British Medical Association (BMA). Dr. Rubulotta is a member of the European Board of Intensive Care Medicine (EBICM), the European Accreditation Council for Continuing Medical Education (EACCME) in the Union of European Medical Specialities (UEMS), a member of the Governance Board of the EACCME, and a new member of the UEMS school of examiners. Dr. Rubulotta completed her training in end of life and compassionate care Medicine, in the USA at Brown University, Rhode Island University Hospital in Providence, where she received certification for the protection of study volunteers of Rochester University. She has been working in the ethics group of the ESICM for several years, participating in international projects such as Conflicus, Europain and Appropricus. Dr. Rubulotta has contributed to the "Rapid Response Systems Conference" since 2007 and she is a founding member of the International Conference of the Society for Rapid Response Systems. An avid researcher, Dr. Rubulotta has published papers, abstracts, chapters and reviews, mainly on education, sepsis, rapid response systems and ethics and has been an invited speaker at many national and internal meetings. She won the Best Paper Award given by the Anna Lindh EU foundation in 2007. Dr. Rubulotta also plays water polo at a semiprofessional level and has won the masters world championship four times. ■

Is there a 'weekend effect' for ICU mortality?

The risk of dying in the intensive care unit (ICU) is higher for patients admitted at the weekend compared to those admitted on a weekday, according to a retrospective study of registry data from Austria published in *Critical Care* (Zajic et al. 2017). However, the risk of dying in the ICU on a weekend was found to be lower than on a weekday, highlighting the complexity of the so-called 'weekend effect'.

The study analysed data on 167,425 patients collected from 119 ICUs across Austria between 2012 and 2015, taking into account severity of illness at admission, reason for admission, chance of discharge from the ICU to the hospital or home and risk of death following discharge to the hospital. Data was obtained from the Austrian Centre for Documentation in Quality Assurance in Intensive Care.

The researchers found that severity of illness varied noticeably between weekends and weekdays, with more patients with a higher severity of illness being admitted on a Saturday or Sunday. The casemix was also different at the weekends, with more patients being admitted for 'medical' purposes as opposed to 'scheduled surgery'. The chance of being discharged to the hospital from the ICU on a weekend was lower than on a weekday.

Lead author Dr. Paul Zajic, from Medical University Graz, Austria, commented in an email to *ICU Management & Practice* that the researchers did not expect to find such multifaceted "weekend effects" and the actual decrease in mortality at weekends could be regarded as a surprise. He added that critically ill patients and their families may rightfully expect the same level of critical care to be provided at weekends and weekdays and healthcare professionals should have a high level of alertness for the needs of patients admitted to ICUs at weekends. Further research focused on the process of providing critical care at weekends is necessary, he said.

Dr. Zajic further commented in a media release: "We noticed that several key interventions in the ICU were less likely to be performed at the weekend, suggesting that the increased mortality in the week is not due to an increased rate of something that would increase mortality immediately, but is more likely to be caused by systematic issues that prevent optimum provision of care for critically ill patients at weekends and so raises their risk of dying in the days following a weekend admission". ■

Reference

Zajic P, Bauer P, Rhodes A, Moreno R, Fellinger T,Metnitz B, Stavropoulou F, Posch M, Metnitz PGH (2017) Weekends affect mortality risk and chance of discharge in critically ill patients: a retrospective study in the Austrian registry for intensive care. Critical Care, 21:223.

Study: AKI alerts associated with lower mortality, LOS

A clinical decision support system (CDSS) that monitors blood creatinine levels in hospitalised patients to alert physicians to potential acute kidney injury (AKI) was associated with a small but significant reduction in mortality and hospital length of stay (LOS), according to research from the University of Pittsburgh and UPMC published in the *Journal of the American Society of Nephrology.*

The benefits of earlier detection of acute kidney injury include earlier intervention to mitigate loss of kidney function, and reduced healthcare costs as a result of avoiding progression to severe and permanent kidney damage. With an annual frequency of AKI in hospitalised U.S. patients of about 12% (2.2 million people), these results would translate into more than 17,000 lives and $1.2 billion saved per year, say the researchers.

The clinical decision support system is a computer program that reports in the Cerner EHR, used in 14 UPMC hospitals. If levels of serum creatinine rise too high or fast, an alert in the patient's EHR informs physicians that AKI could be present. It also helps determine the stage of injury based on changes from the patient's baseline kidney function.

Results

The researchers analysed the records of 528,108 patients between October 2012 and September 2015: 181,696 patients for 12 months before the alert system was implemented, and 346,412 patients for 2 years afterward. AKI was diagnosed in 64,512 patients (12.2%): 20,035 pre-implementation; 44,477 implementation.

The crude mortality rate for patients with AKI was 10.2% pre-implementation and 9.4% post-implementation. For patients without AKI, there was no change in crude mortality rate. Hospital length of stay for AKI patients decreased from 9.3 days pre-implemtnation to 9.0 days post-implementation. There was no change for patients without AKI.

The results also showed a decrease of 2.7 percent in dialysis rates. The researchers report a large effect on mortality in patients aged 60 years and older. They note that the mechanisms by which hospital mortality, LOS and dialysis were reduced are unclear. They conclude that the results "support the development of CDSS to enhance early AKI detection but demonstrate that passive alerting will have only a limited effect on patient outcomes and more action-based CDSS will likely be needed to increase effect."

Future developments

Senior author John Kellum, MD, professor of critical care medicine and director of the Center for Critical Care Nephrology at Pitt's School of Medicine told *ICU Management & Practice* "We are continuously refining the program based on performance. For example, the analytics behind determining baseline creatinine continue to evolve and we also have filters to reduce false positives. We also plan to add an active treatment module based on pharmacy evaluation for nephrotoxins."

Reference

Al-Jaghbeer M, Dealmeida D, Bilderback A, Ambrosino R, Kellum JA (2017) Clinical decision support for in-hospital AKI. J Am Soc Nephrol, 29: doi. 10.1681/ASN.2017070765.

Adult education for ICU management

A better way

Frequently, formal education sessions crafted for medical professionals fall short in their ability to advance the competency of providers. There is a better way! It involves utilising knowledge from the adult education world and applying it to our critical care domain. A move to active teaching and learning strategies improves outcomes from the education. Sequential exposure to information is also useful. Improvement in the learner's ability is best achieved when both the planner and the learner follow adult education principles.

Frequently, formal education sessions crafted for medical professionals fall short in their ability to advance the competency of providers. The less than ideal effectiveness is secondary to a number of causes, including too great a reliance on past approaches and a general lack of understanding of some basic tenets of adult education. These deficiencies in our knowledge on how to best educate stem from a historic approach that has deep roots in the apprenticeship model. In such a model the content expert is perceived to be the best educator. Furthermore the historic approach is based significantly on passive education approaches, such as presentations. Some have called the linking of these two historic approaches the 'sage on the stage' model.

Unfortunately, people learn in different ways and a singular approach to education serves as an inherent barrier to success. Importantly, the content expert may indeed hold the richest dataset related to the disease, disorder, syndrome, etc., but may not possess the ability to impart such knowledge to others in a manner that facilitates their use and implementation of the knowledge. This is not because the content is deficient; in fact the material will typically be robust and 100% accurate. The problem is that too much material is presented in too short a period of time. Key take-home messages are not highlighted or transmitted in a manner in which the audience will learn from them. Essentially such approaches amount to awareness phenomena where the audience leaves aware of facts, but is not prepared to use these facts and improve their practice.

There is a better way! It involves using knowledge from the adult education world and applying it to our critical care domain. It involves transitioning from passive forms of education to more active formats. Active learning is achieved through active teaching methods. The 'sage' becomes a facilitator and a coach.

Four adult education principles

There are numerous adult education principles that come into play. In this manuscript I will focus on four of them, as I believe these to be critical:

1. Dale's cone of learning
2. Ebbinghaus' forgetting curves
3. Dreyfus' ladder of skills acquisition
4. Knowles' andragogy.

Dale's cone of learning

Most of us have heard some of the basic tenets espoused in Edgar Dale's cone of learning but may not have known the attribution. Dale taught us that we remember/learn more in a quasi-hierarchical manner starting with the least amount of retention when we only read, proceeding to the highest levels of retention when we can discuss and do actions. Although what is below is not exactly what Dale said, it is the most common interpretation of his comments. We remember/learn:

- 10% of what we read
- 20% of what we hear
- 30% of what we see
- 50% of what we hear and see
- 70% of what we say and
- 90% of what we say and do.

This is at the root of why passive forms of learning, those close to the top of the list, are simply less impactful, even though they may be the most common approach used in lectures, grand rounds and medical meetings. The list also helps us to understand why active forms that include saying and doing increase the likelihood of being remembered. These are the principles that lead us to understand why read back can be effective, why workshops are effective and why simulation is so important. Such approaches also allow for those who are auditory learners and visual learners to be better served.

Ebbinghaus' forgetting curves

Herman Ebbinghaus reminded us that if we can learn, we can also forget. His studies taught us that it takes multiple exposures to the material for it to become more permanently engrained. The graph shows how with each subsequent exposure our knowledge decay is lessened and thus our memory is more permanent. Thus the present approach of a single lecture on a topic is a misfire on both Dale's and Ebbinghaus' principles. If we want the new knowledge to lead to improvements (actions) then we should plan for repeated exposures spaced apart over time and utilise active teaching methodologies.

Dreyfus' ladder of skills acquisition

The Dreyfus brothers (Stuart and Hubert) taught us that if we are educated correctly we can progress from novice to

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expert after transition through being competent and proficient. In medicine, we have interpreted this to mean that when we finished our training we were deemed experts. This turns out to not be true. In fact, we are more likely proficient at that stage. Developing into an expert takes time, volume of case exposures, dedicated personal development (ongoing learning) and episodes of effective self-reflection. As most clinicians had no exposure to training as an educator, they were not aware of Dreyfus' and Ebbinghaus' work. Thus not only did we not reach the height we assumed (proficient versus expert) we were at risk of falling backwards from proficient to competent (i.e. forgetting).

Knowles' andragogy

The work by Malcom Knowles ties a lot of this together for us. Knowles taught us that adult learning was facilitated when we followed a certain set of principles. These include:

- Adults need to know the reason for learning something
- Experience, including errors, is the basis for learning
- Adults need to be responsible for their decisions on education and involved in planning and evaluation
- Adults are more interested in learning subjects having immediate relevance to their work and/or personal lives
- Adult learning is problem-centred rather than content-oriented
- Adults respond better to internal versus external motivators.

Applying the principles

I believe that physicians are very 'Knowlesian'. If all or at least most of these principles are not utilised in the planning and conduct of education activities then it will simply be less effective. So how might the above principles play out when designing education and when choosing activities that meet lifelong learning goals?

From the planning perspective, we need to have a clear understanding of the target audience and its needs. This may require literature review or at times survey data to understand the gap between their present state of knowledge and ability and their desired state of knowledge and ability. Once the gaps have been clearly delineated, then planners can decide what instructional design methodologies are best to achieve improvement toward the ideal state. Common active teaching methodologies include workshops, simulation and activities like in-situ mock codes. Lectures should be shortened and used as a preface to more active methods. Interaction is key so discussions, extensive question and answer sessions, interviewing experts and pro-con debates are all more active than simple presentations. Even during didactic lectures methods such as short pauses for self-reflection by the audience, or having short periods of small group discussions are better than simply showing and speaking to 50 slides in a darkened room.

"THE BEST EDUCATIONAL EXPERIENCE IS ACHIEVED BY USING MIXED METHODS AND SEQUENTIAL EXPOSURE AS THE MEANS TO ENHANCE THE COMPETENCY OF THE INDIVIDUAL"

Mixed methods work better than singular method approaches. Having the learners complete pre-work, like reviewing an article, guideline or video allows learners to establish a common base before attending. The event then can focus more at the utilisation of knowledge and thus can be more workshop or simulation based. At times it can even be generative of new knowledge or approaches. Such an approach, where the primary work is done prior to the 'classroom' and the 'classroom' is dedicated to demonstrating competency is commonly referred to as a 'flipped classroom' approach.

Then subsequent to the event, maybe 30 or 60 days later, learners might be asked to link to a portal that includes case vignettes. This allows for an assessment of retention as well as applicability. Thus the best educational experience is achieved by using mixed methods and sequential exposure as the means to enhance the competency of the individual.

In addition to the planners utilising these approaches, physicians should use the core principles in choosing educational activities. If they merely choose based upon the location of the event or the number of credits available, the likelihood that they will learn and incorporate new knowledge and ability is quite low. However, when they take responsibility for their decisions on education and they seek out and attend education that meets the above principles, they are highly likely to incorporate new knowledge and ability and thus improve performance and outcomes. Sometimes this is referred to as a commitment to change/improve. We need to remember that we are also patients, and we want our personal physicians to make smart relevant choices in their educational content. If the above principles are followed then formal education sessions are less likely to fall short of our objectives. ■

Conflict of interest

Todd Dorman declares that he has no conflict of interest.

Suggested readings

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"Vision without action is a daydream. Action without vision is a nightmare."

The COmpetency-BAsed Training programme in Intensive Care for Europe and other world regions (CoBaTrICE)

The COmpetency-BAsed Training programme in Intensive Care Medicine (CoBaTrICE) has been the European Society of Intensive Care Medicine (ESICM)'s vision to achieve a unified and harmonised model of training doctors caring for critically ill patients and their families around the world. Harmonisation is a key part of the concept because this enables free movement of intensive care medicine (ICM) specialists around the world. The vision is that CoBaTrICE will make better doctors in the future by providing the competencies needed to offer the highest level of care in the field of ICM. CoBaTrICE has defined the environment and the tools required to achieve those and to facilitate mobility and modernisation in the field of ICM.

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The COmpetency-BAsed Training programme in Intensive Care Medicine for Europe and other world regions (CoBaTrICE) is an international partnership of professional organisations and intensive care providers (**cobatrice.org/en/index.asp**) focused on improving the quality of care of critically ill patients through education and training (Bion and Rothen 2012; CoBaTrICE Collaboration 2009). The CoBaTrICE collaboration was formed in 2003 and initially funded by the European Commission Leonardo da Vinci programme (2003-2010) (Bion and Rothen 2012; Barrett and Bion 2006). It is currently supported by the European Society of Intensive Care Medicine (ESICM, **esicm.org**), but it works in close collaboration with European medical organisations (EMOs), in particular the Union of European Medical Specialists (UEMS).

The objectives of this programme are:

- To assure high-quality education in ICM
- To harmonise training and accreditation in ICM, in collaboration and without interfering with national regulations or regulatory bodies
- To facilitate free movement of ICM professionals across Europe and other world regions through providing a harmonised competency-based training programme in ICM.

In this article we describe the growth and expansion of the CoBaTrICE programme over the last decade in Europe and worldwide (Bion and Rothen 2012; Convention on the recognition of qualifications concerning higher education in the European Region 1997 [Lisbon Recognition Convention]).

"ENHANCEMENT AND HARMONISATION LOOK SET TO CONTINUE WITH FURTHER DEVELOPMENT OF THE COBATRICE PROGRAMME AND ENGAGEMENT OF KEY STAKEHOLDERS"

Europe: mobility and modernisation

One of the basic principles in the European Union (EU) is the free movement of nearly all aspects of life and trade, namely funds, manpower and products. One of the few fields where free movement is not fully implemented is in the healthcare system, where the provision of services is the responsibility of each European Member State (Lisbon Recognition Convention; Directive 2005/36/EC). In 1957 the mutual recognition of diplomas and accreditations reinforced the creation of the European Economic Community (EEC) and afterwards the EU. Physicians can work in the EU using an automatic mutual recognition of their medical degree and specialty or a process of equivalence following the European Directive 2005/36/EC. This Directive has an annex, where the specialties that can benefit from an automatic recognition are listed and called "primary specialties." All medical disciplines missing from the annex require national equivalence for recognition (Directive 2005/36/EC; Directive 2013/55/EU). The EU Directive 2005/36/EC revision was approved by the European Parliament in October 2013 with an amended list of primary specialties. Unfortunately, ICM is still not part of the annex. Since 2005 the situation has been further complicated by the EU Healthcare Directive 2011/24/EU that allows patients but not doctors working in medical specialties outside the annex to move across countries. Moreover, the impact of new developments such as Brexit and the Catalan independence referendum require further evaluation to determine the impact of these changes on free movement of medical specialists working in non-primary disciplines such as ICM in the future (European University Association 2011; Rhodes et al. 2011).

Mobility equals modernisation

The Sorbonne Declaration of 1998 demanded an increase in European mobility as a chief priority (Rubulotta et

al. 2011; European University Association 2011). The Bologna Declaration (1999) promoted the same principle and the European Union's "Education & Training 2010" agenda (the educational manifestation of the Lisbon Process) named mobility as one of its "most important objectives" for European education. In parallel to these collective European efforts, national and regional governments have been trying to boost mobility into or out of their countries through scholarship or loan schemes, amongst other initiatives. Many governments, including the UK, have campaigned to attract the best candidates from other regions. In 2011 the European Ministers also highlighted the importance of shared and exchange of knowledge to improve standards of training programmes (European University Association 2011). CoBaTrICE members believe that mobility and modernisation can be translated in better doctors' training and patients' care (Bion and Rothen 2012; Convention on the recognition of qualifications concerning higher education in the European Region 1997). CoBaTrICE was one of the first successful programmes in healthcare to generate a curriculum and a syllabus based on agreed minimum competencies. CoBaTrICE currently embraces the concept of mobility of specialists and shared knowledge by providing a high-quality, competency-based training programme that can be recognised and accredited in different European countries (Barrett and Bion 2006; CoBaTrICE Collaboration 2009; Convention on the recognition of qualifications concerning higher education in the European Region 1997).

Nevertheless, ICM is an example of a medical specialty that has yet to be harmonised in Europe despite the long-lasting and active collaboration with EMOs and National Training Organisations (NTOs). CoBaTrICE was established in 2003, two years before the EU directive for the free movement of specialists; however (Convention on the recognition of qualifications concerning higher education in the European Region 1997; Directive 2005/36/EC), there is still considerable diversity in educational structures, processes and quality assurance in ICM training across Europe (Barrett and Bion 2006; CoBaTrICE Collaboration 2009). On a positive note, an increasing number of European countries have formally adopted the CoBaTrICE competencies as part of their postgraduate training programme in ICM (18 European countries) with a further 10 countries planning to adopt it in the near future (**Figure 1**).

CoBaTrICE provides healthcare systems with an opportunity to determine the best approaches for quality assurance and long-term improvements in the care of critically ill patients and their families through education and training of specialists. Until recently, ICM was only recognised in two European countries (Switzerland and Spain) as a primary specialty. Since June 2010, direct access to training and accreditation in ICM became possible in the United Kingdom, Ireland, Portugal, Belgium and the Netherlands (Rubulotta et al. 2011; Rhodes et al. 2011). Enhancement and harmonisation look set to continue with further development of the CoBaTrICE programme and engagement of key stakeholders.

CoBaTrICE 2.0: the update

The CoBaTrICE syllabus comprises the aggregate of all the knowledge, skills, behaviours and attitudes required for each competence in ICM. Each section is divided into 12 domains (resuscitation, diagnosis, disease management, interventions, procedures, perioperative care, comfort and recovery, end-of-life care, paediatric care, transport, safety and management)

Figure 1. List of countries that have adopted the CoBaTrICE

plus basic sciences (cobatrice.org/en/index.asp). The syllabus may be used by trainees and trainers to aid reflective learning, formal teaching and to guide assessment. In 2016 CoBaTrICE was updated (CoBaTrICE 2.0) to include new competencies to reflect changes in ICM practice. A self-report web-based English language survey was developed and piloted through several iterations by the CoBaTrICE steering committee, with input from non-native English speakers. The survey was distributed via email to all European national coordinators, NTOs, ICM trainees, ESICM members and stakeholders. Clarification of responses was sought by email or telephone where necessary. The aim of the process was to adapt CoBaTrICE to recent developments, knowledge, guidelines, definitions, methods of assessment, monitoring and therapeutic concepts in ICM. The principle was to use a pragmatic approach, keep the list of competencies unchanged whenever possible and costs limited. The updating process was entirely funded by the ESICM to avoid any conflict of interests. At the end of the process, new competencies included were ultrasound, echocardiography, extracorporeal membrane oxygenation and rapid response teams. The CoBaTriCE 1 syllabus has now been adopted and translated into 10 different languages. The new updated list of competencies will be translated following its publication and it will be freely available on the web in due course.

Framework of the CoBaTrICE committee

The European Board of Intensive Care Medicine (EBICM) consists of 9 members of the ESICM (including the chair of CoBaTrICE) and 9 members of the Multi Joint Commission for Intensive Care Medicine (MJCICM), namely one member of each primary speciality: Anaesthesiology, Cardiac Surgery, Cardiology, Internal Medicine, Neurology, Neurosurgery, Paediatrics, Pneumology & Surgery. Furthermore, 9 additional members from each of the relevant European societies can be invited to attend EBICM meetings.

In the context of the ESICM, the CoBaTrICE committee forms part of the Division of Professional Development (DPD) and comprises the CoBaFaculty and the CoBaForum. The CoBaFaculty is a committee with 6 voted members. The CoBaForum consists of key stakeholders from different European countries with an interest in education and training in ICM. The CoBaForum can be considered a hub with the aim of advancing the Society's projects and objectives with the support of other NTOs, scientific societies and stakeholders. The CoBaForum (creative hub) typically presents proposals to the CoBaFaculty (executive group of the project). **Figure 2** shows the flow. The chair of the CoBaFaculty is part of the EBICM and is therefore able to share finalised ideas with representatives of the 9 sections and the 9 European scientific societies representing primary specialties involved in the care of critically ill patients. The UEMS is an advisory board of the EU Commission. The UEMS sets standards for high-quality healthcare practice that are conveyed to the relevant authorities and institutions of the EU and the national medical associations, stimulating and encouraging them to implement its recommendations.

CoBaTrICE is a scientific concept that advises and supports NTOs but remains impartial of political matters.

Wider dissemination of the CoBaTriCE programme: the future

The CoBaTrICE programme represents the pillar of all educational activities within the ESICM (**Figure 3**). The ESICM Academy is a new project that started in 2015 with the vision of integrating the society's education activities. Within the ESICM Academy is a new e-learning platform that provides learning pathways (e-modules and e-courses) for individuals based on the CoBaTrICE competencies. CoBaTrICE has individualised tools, such as the electronic CoBaFolio, where trainees and trainers can track progress of competencies from the beginning to advanced stages of their professional career. This is crucial, because documentation of newly acquired or maintained competencies can be transferable and used to enhance mobility. The European Diploma in Intensive Care (EDIC) exam is a key component of the ESICM's education strategy. The blueprint of the exam is based on the CoBaTrICE competencies, which define the minimum standard of knowledge, skills and attitudes required for a doctor to be identified as a specialist in ICM. The EDIC exam has recently obtained accreditation by the Council of European Specialist Medical Assessment (CESMA) in the UEMS and is recognised as a high-quality postgraduate exam. Candidates for the exam need to be fully registered medical doctors (i.e. internship completed). They should be enrolled in a national training programme in a primary specialty, namely: Anaesthesiology, Internal Medicine, General Surgery (and other surgical specialities), Accident and Emergency Medicine, or ICM. The aim of the written exam (EDIC part I) is to test the theoretical knowledge (summative knowledge), whereas the oral part (EDIC part II) aims to test professional conduct at the end of the training (formative knowledge). The exam is intended to be complementary to specialist postgraduate medical training and the taking of the two components of the exam should correspond to stages of experience. The number of participants taking the exam outside Europe has increased dramatically over the last few years and includes specialists coming from all continents. The recognition of the high standard of the EDIC exam and greater popularity is reflected in the increased number of candidates taking the exam, from 519 (2013-2014) to 867 (2016-2017) respectively.

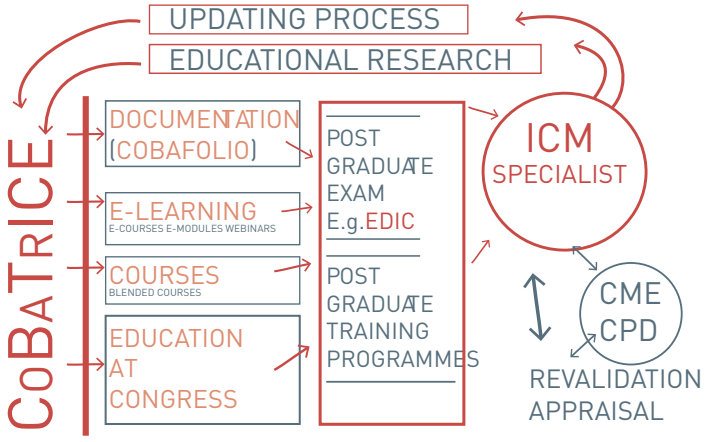

Figure 1.CME continuing medical education CPD continuing professional development EDIC European Diploma in Intensive Care Medicine

Exam preparation courses and focused blended courses have also been developed and successfully delivered around the world. CoBatrICE has been used to set the curriculum and the format of such courses. Instructors for those courses have now been trained in Europe, the Middle East and Asia.

CoBaTrICE is now an integral part of many postgraduate training programmes in Europe. It provides a framework for future development of educational material (e.g. courses, e-learning content), assessment (exam) and other education tools (porfolios, entrustable professional activities) in ICM. The vision is to obtain further dissemination and adoption of CoBaTrICE in Europe and worldwide, paving the way for modernisation and mobility to have better doctors in the field of ICM. ■

Abbreviations

CoBaTrICE COmpetency-BAsed Training programme in Intensive Care Medicine for Europe

DPD Division of Professional Development

EBICM European Board of Intensive Care Medicine

EEC European Economic Community

EDIC European Diploma in Intensive Care Medicine

EMOs European medical organisations

ESICM European Society of Intensive Care Medicine

EU European Union

ICM intensive care medicine

MJCICM Multi Joint Commission for Intensive Care Medicine

NTO National Training Organisations

UEMS Union of European Medical Specialists

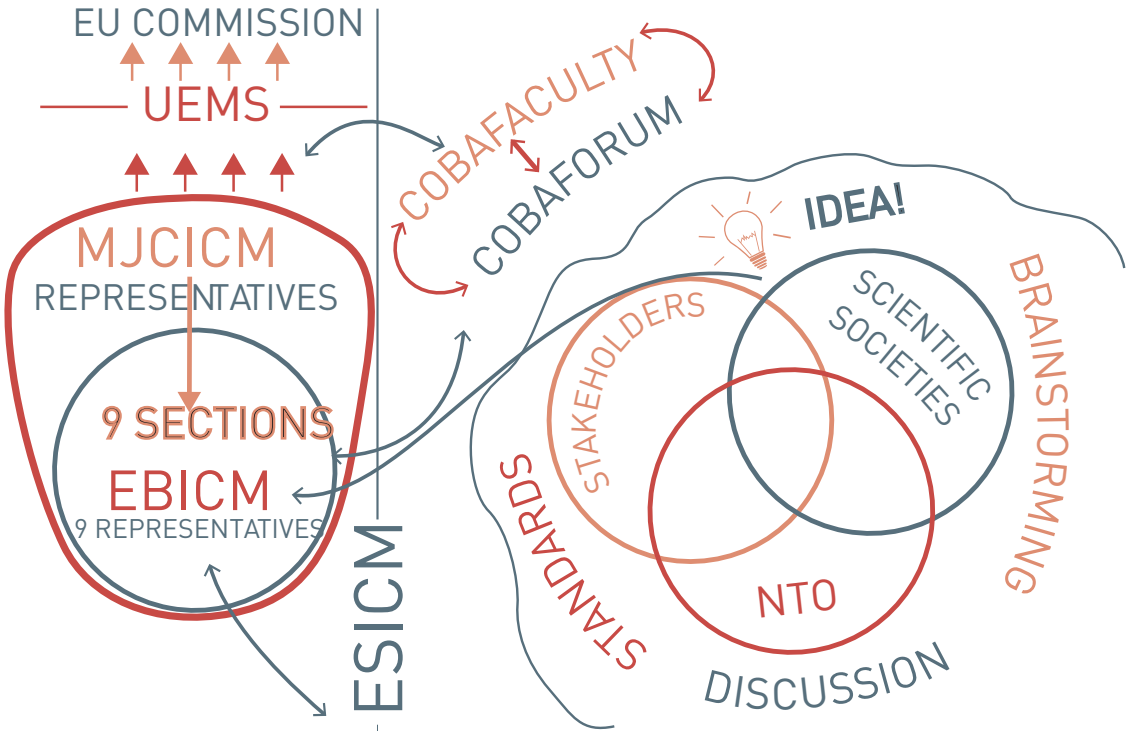

Figure 2. Flow and interaction between the European Society of Intensive Care Medicine and the Union of European Medical Specialists using the mediation of CoBaTrICE

EBICM European Board of Intensive Care Medicine ESICM European Society of Intensive Care Medicine MJCICM Multi Joint Commission for Intensive Care Medicine NTO National Training Organisations UEMS Union of European Medical Specialists

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Sepsis code implementation at Vall d'Hebron University Hospital

Rapid diagnostics key to success

Implementation of a sepsis code, Código Sepsis, in October 2015 at the Vall d'Hebron University Hospital in Barcelona has led to better detection and a significant reduction in mortality. The hospital is the largest in Barcelona, with more than 1,100 beds and 7,000 employees.

The objectives of Código Sepsis are to increase suspicion of sepsis and septic shock, improve the early administration of initial antibiotic treatment, early and adequate resuscitation, facilitate early diagnosis of the infection source and place patients in different wards depending on clinical complexity. These objectives and the results obtained have been achieved with daily, fluid and efficient coordination among the physicians of Microbiology, Intensive Medicine and Emergency.

The new protocol was developed with the involvement of the departments of Intensive Care Medicine, Emergency, Microbiology and Nursing as well as the Laboratory.

Our group has established that for all patients with documented or suspected infection, Código Sepsis should be activated by at least one of the following two criteria:

- Criteria A: Acute alteration of the level of consciousness not explained by other causes.
- Criteria B: Hyperthermia or hypothermia and/or tachycardia and/or tachypnoea and/or desaturation (any of them) plus arterial hypotension.

Sepsis bundle

In all patients in which the Código Sepsis is activated, we suggest to be performed that what we call the "bundle of the first 30 minutes", as follows:

1. Place two short and thick venous accesses and concomitantly perform the extraction of the first blood culture and blood samples for the laboratory. The second blood culture will be obtained 5-10 minutes later in a different anatomical location. We have developed a specific analytical profile for Código Sepsis in our hospital information system. This profile includes haemogram, haemostasis, renal and liver profiles, ions, transaminases, bilirubin, lactates, biomarkers (procalcitonin and C-reactive protein), immunoglobulins, blood cultures and samples for the Sepsis Bank.
2. Oxygen therapy with an objective of $SpO_2 > 90\%$.
3. If hypotension or lactates are > 3 mmol/L: Initiate immediate resuscitation with crystalloids (30 mL/kg), preferably with Ringer's lactate. Avoid administration of colloids (except seroalbumin). The existence of cardiac insufficiency may contraindicate fluid resuscitation.
4. Administration of the initial dose of antibiotic treatment in the first hour after the recognition of sepsis and if possible within the first 30 minutes. There is an empirical antibiotic treatment protocol based on syndromic diagnoses that aims to facilitate and expedite the antibiotic choice.
5. Priority is given to rapid antibiotic treatment in patients with sepsis/septic shock, so no diagnostic or therapeutic measures can delay the administration of the antibiotic.
6. Placement of a urinary catheter.
7. Perform a 12-lead ECG.
8. Sample potential source of sepsis.
9. Consider and perform the complementary examinations for the diagnosis of the source of infection (radiography, ultrasound, computed tomography).

New laboratory workflow

In the microbiology laboratory, a new workflow for samples from patients with suspected sepsis ensures that these samples receive priority processing 24h/7d. In addition, the laboratory information system (LIS) has alerts to identify patients with a sepsis code and warn of the positivity of blood cultures. The most modern technology available is used to obtain a rapid aetiological diagnosis and antibiotic susceptibility profile of the causative agent(s) of sepsis. The close collaboration between the microbiology laboratory, the sepsis code team and the physician responsible for the septic patient makes it possible for an early evaluation of empirical treatment to be made and adapted if needed.

Microbiological diagnosis

Mass spectrometry is used, from colony and direct blood culture, for bacterial identification. Direct antibiogram of positive blood culture is performed (without waiting for the growth of the microorganism) in order to obtain the results sooner.

Obtaining rapid initial antimicrobial susceptibility results allows follow-up testing of reserved drugs not initially included in the standard antibiogram to quickly follow in cases where multiresistance is detected. Combinations of antimicrobials are also evaluated in the most complicated scenarios. As we have a multidisciplinary sepsis group, a clinician is available to receive microbiological results at any time of day. This has allowed de-escalation of treatment if needed and also extension of coverage to yeasts if the microbiological results point in that direction.

Optimisation of antibiotic treatment

It is important to know the minimum inhibitory concentration (MIC) value, as one of the essential aspects of treatment is to keep the antibiotics at adequate plasma levels. Alterations in distribution volumes may cause suboptimal plasma levels. Knowledge of the MIC value in sepsis and septic shock is of particular importance since it may be a factor that modifies the choice of antibiotic

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to be used. It is also important to correctly infer the possible mechanisms of antimicrobial resistance produced by the organism responsible for the infection.

Implementation of Código Sepsis has increased the number of patients with a confirmed microbiological diagnosis, thus allowing the clinicians to make informed decisions about antimicrobial treatment. Prioritisation of samples in the lab has reduced time to final diagnosis, thus helping clinicians to make faster decisions.

"SEPSIS IS AN AUTHENTIC MEDICAL EMERGENCY AND A TIME-DEPENDENT PATHOLOGY"

We have seen an improvement in some process-of-care indicators such as faster time to appropriate antibiotic therapy or a reduction in DDDs per 1,000 occupied bed days of carbapenems. We expect to see improvements in resistance patterns, better outcomes and lower costs over time.

Multidisciplinary group

A multidisciplinary group, which includes the sepsis team of Intensive Care Medicine, Emergency and Microbiology, is responsible for the daily control of Código Sepsis. Each working day and by the first hour, the microbiology sepsis team identifies the patients activated by the sepsis code, analyses their microbiological samples (not only the current ones but also the previous ones) and reports them to the rest of the group. The emergency sepsis team is responsible for the clinical evaluation and follow-up of activated patients who remain in the ER, while the Intensive Care Medicine sepsis team is responsible for the same function in the rest of the hospital. The Intensive Care Medicine sepsis team also records all patient data in a database shared by all members of the code sepsis team.

Table 1. Code Sepsis implementation 15 October 2015-17 February 2017

Total codes	712
Average codes per month	46
Where activated	Emergency Department (39.6%) Critical Care Department (21.6%) Hospitalisation wards and other units (38.8%)
Patient status	78.9% had sepsis 27.1% sepsis 51.8% septic shock
False positives	21% 8% in patients with no infection 13% in patients with infection but without sepsis
Source sites for infection	abdominal (32.4%) respiratory (27.8%) urinary (21.6%).
Microorganisms	Escherichia coli (28.2%) Staphylococcus epidermidis (7.7%) Klebsiella pneumoniae (7.2%) Staphylococcus aureus (5.1%) Proteus mirabilis (3.6%) Staphylococcus sp. (3.1%) Enterococcus faecium (3.1%) Pseudomonas aeruginosa (3.1%)
Mortality	41.7% (2005) 26.7% (2016) *

* the analysis of mortality in 2005 only includes patients admitted to the ICU for sepsis and current data correspond to all the septic patients who were activated by the sepsis code in the hospital.

Sepsis Bank

The Sepsis Bank of the Vall d'Hebron University Hospital Biobank is composed of more than 500 septic patients. It holds samples taken at the sepsis onset, that is when Código Sepsis is activated, and also pre-sepsis samples which have been taken 24h prior to the Código Sepsis activation as well as post-sepsis samples, taken 24h, 72h and 7 days after the onset. It also contains samples from non-infectious systemic inflammatory response syndrome patients as well healthy people, which would represent a disease control group. The Sepsis Bank is conceived for biomedical research and to facilitate clinical research of sepsis not only at our centre but also to the entire scientific community. ■

This article was prepared in partnership with Accelerate Diagnostics. To find out more about rapid MIC diagnosis, visit http://acceleratediagnostics.com.

Making critical care education BASIC

A collaborative approach to training

This article highlights the key current challenges of intensive care training and education. We share our experience of utilising modern educational techniques through the BASIC Collaboration to facilitate global critical care training.

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Critical care is a young and rapidly expanding specialty. This brings particular challenges in training staff. Survey data demonstrate that many medical schools do not teach critical care, and studies consistently show a failure by junior medical staff to recognise and appropriately manage critically ill patients (Shen et al. 2003; McQuillan et al. 1998). Thus doctors entering training in intensive care have very rudimentary knowledge of and skills in critical care. In parts of the world the problem is exacerbated by shorter working hours, which raise concerns that training will be impaired (Moonesinghe et al. 2011).

Training in medicine has traditionally followed a master and apprentice model, which is well suited to established specialties that are not undergoing rapid growth. However, this is not the case in critical care where a significant imbalance between masters and apprentices is common.

Technological advances have also expanded the scope of practice of critical care practitioners. Ultrasound machines are now widely available at affordable cost, and with that availability has come the expectation that critical care practitioners will acquire the expertise to use these devices (Mayo 2011). Non-medical technological advances also mean that our traditional approach to training may require re-thinking. Traditional approaches to medical education have emphasised acquisition and retention of knowledge, with an emphasis on memory. However, the widespread availability of mobile devices incorporating Internet connectivity and high memory capacity should prompt a greater emphasis on training doctors to apply knowledge rather than memorise facts (Mobasheri et al. 2015). Furthermore, patient safety discourages reliance on memory in favour of checking reference sources (Nolan 2000).

As a result it is necessary to devise training programmes that use the time of the available masters in the most efficient manner, emphasise development of skills and allow training of large numbers of healthcare workers. Furthermore the rapid growth of critical care research, in particular the strength of collaborative investigator-led trials groups, has led to the need to frequently update the content of training programmes (Marshall 2017).

The herculean task of providing suitable training to sufficient numbers of critical care healthcare workers is well illustrated by the example of China. It has previously been estimated that, even with a relatively low Intensive Care Unit (ICU) bed provision of 1-2% of hospital beds, the total number of ICU beds in China was approximately 52,000. Assuming a low ratio of 4 nurses per bed and 1 doctor for 5 beds, this equates to a need for training for approximately 200,000 nurses and 10,000 doctors. At that time there was no formal training programme in either intensive care medicine or nursing in China (Du et al. 2010).

However, by concentrating on critical care as a geographical location this illustration underestimates the magnitude of the task. There is an increasing awareness that our specialty involves care of critically ill patients, regardless of their location, not just the care of patients in ICUs (Adhikari et al. 2010).

Solutions

Our belief is that the solution lies in a collaborative approach to education. This allows a pooling of efforts to develop and provide high-quality education that is responsive to changing needs, practice and technology. One of the best early examples of this approach was the development and dissemination of the Fundamentals of Critical Care Support (FCCS) course by the Society of Critical Care Medicine. This course consists of pre-course reading, short lectures and small group teaching (Joynt et al. 2011). The material is written and updated by a small group of intensivists with an interest in education, but the course is delivered at a local level by a large number of intensivists in multiple locations across the globe. A similar approach has been taken by our group and we describe our experience below.

Apart from the gain in efficiency resulting from avoiding repeated re-invention of the wheel, this approach has the advantage of making more efficient use of masters' time by minimising the need to spend time on simple knowledge transfer. Instead, candidates are expected to acquire the relevant knowledge by reading the course manual before attending the course, so that the course can be devoted to reinforcing important points and acquisition of skills (both practical and cognitive). This is the underlying principle of the 'flipped classroom' approach, which is gaining favour in education. In its purest form students acquire all the necessary knowledge before attending face-to-face teaching, which then concentrates on application of that knowledge to problems.

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Figure 1. BASIC Collaboration course venues since 2004. Reproduced from https://multiplottr.com/?map_id=125266

This is the reverse of traditional classroom teaching, in which didactic teaching occurs face to face and problem solving is carried out unsupervised, in the form of homework.

The BASIC Collaboration

The BASIC Collaboration was founded in 2004, with a logistic and administrative base in the Department of Anaesthesia & Intensive Care, The Chinese University of Hong Kong. While inspired by the FCCS course and the Society of Critical Care Medicine, the Collaboration differs in a number of aspects. Firstly, it is entirely focused on medical education. Secondly, a deliberate decision was made not to charge licence fees for running courses. Thirdly, the Collaboration is deliberately international. Since its inception and the development of its first course, Basic Assessment and Support in Intensive Care (BASIC) (Joynt et al. 2011; Douglas et al. 2010), the Collaboration courses have been run in over 50 countries (**Figure 1**), the number of different courses has grown (**Table 1**) and the number of healthcare workers trained each year has grown steadily (**Figure 2**). An estimated 40,000 healthcare workers have been taught in total. In keeping with our belief in collaboration, courses have been developed with the European Society of Intensive Care Medicine (Intensive Care Nephrology – beyond BASIC) and Médecins Sans Frontières (BASIC for Developing Healthcare Systems and BASIC DHS for Nurses). In keeping with our belief that our specialty encompasses care of critically ill patients wherever they may be, our portfolio of courses includes acute care in high-resource non-ICU settings (Very BASIC) and in low-resource settings (BASIC DHS and BASIC DHS for Nurses).

What have we learned from the BASIC Collaboration?

Collaboration is better

While the benefits are seemingly self-evident, international collaboration in education lags behind collaboration in research. Each BASIC Collaboration course is written by a small group of authors, but each course benefits from continual informal peer review by multiple course instructors across the world. Instructors are encouraged to submit criticisms and comments, and rapid and recurrent review of the material is facilitated by distribution of course material in an electronic format. Furthermore the material is continually revised to maximise understanding and skill development, based on feedback from both instructors and participants. This is an essential but time-consuming part of the development of high-quality material, which is only possible through collaborative efforts. The process of quality improvement is made worthwhile by the large number of people who are trained. We believe our policy of not charging licence fees improves collaboration by removing any suspicion of financial conflicts of interest.

"A COLLABORATIVE APPROACH TO EDUCATION.. ALLOWS A POOLING OF EFFORTS TO DEVELOP AND PROVIDE HIGH-QUALITY EDUCATION RESPONSIVE TO CHANGING NEEDS, PRACTICE AND TECHNOLOGY"

Flipped classrooms

Over the past 12 years our Very BASIC course has transformed from a partial to a fully flipped classroom format (Gruber

Table 1. Currently running BASIC courses and their development origins

Course	Subject	Target audience	Country base of development team	Launch year
Basic Assessment & Support in Intensive Care (BASIC)	Introduction to adult intensive care	Intensive care novices (physicians)	AU, HK, UK, NZ	2004
Paediatric BASIC	Introduction to paediatric intensive care	Intensive care novices (physicians)	AU, CA, HK, ZA	2012
BASIC for Nurses	Introduction to adult intensive care	Intensive care novices (nurses)	AU, HK	2013
Very BASIC	Acute care of critically ill patients outside ICU	Final year medical students and junior doctors in high-resource settings	AU, HK, NZ, UK	2005
BASIC for nurses on the ward	Acute care of critically ill patients	General ward nurses	HK, NZ	2007
BASIC for Developing Healthcare Systems (BASIC DHS)*	Acute care of critically ill patients	Doctors and medical students in low-resource settings	FR, HK	2011
BASIC DHS for Nurses*	Acute care of critically ill patients	Nurses in low-resource settings	AU, FR, HK	2015
BASIC Science	Basic sciences relevant to intensive care	Junior intensive care trainees	AU, HK, NZ	In progress
BASIC Patient Safety	Patient safety for clinicians	Clinical healthcare professionals	HK, NO, UK	2010
BASIC Clinical Research	Introduction to clinical research	Clinical research novices	AU, CA, HK, NZ	2016
BASIC Transthoracic echocardiography	Echocardiography in critically ill patients	Intermediate Intensive Care trainees	HK	2017
Mechanical Ventilation: beyond BASIC	Mechanical ventilation	Intermediate-senior intensive care trainees and as a refresher for intensive care specialists	HK, NO, NZ	2009
Intensive Care Nephrology: beyond BASIC#	Nephrology relevant to intensive care	Intermediate-senior intensive care trainees and as a refresher for intensive care specialists	HK, IN, NO, NZ, PT, UK	2011
Airway Management: beyond BASIC	Airway management relevant to Intensive Care	Intermediate-senior intensive care trainees and as a refresher for intensive care specialists	AU, HK	2013
Cardiothoracic Intensive Care: beyond BASIC	Post operative cardiac intensive care	Intermediate-senior intensive care trainees and as a refresher for intensive care specialists	HK, NO, UK	2016
Cardiocerebral Resuscitation: beyond BASIC	In-hospital cardiocerebral resuscitation	Hospital doctors	HK, IN, NO	2014

AU, Australia; CA, Canada; FR, France; HK, Hong Kong; IN, India; NO, Norway; NZ, New Zealand; PT, Portugal, UK, United Kingdom; ZA, South Africa

* Developed in collaboration with Médecins Sans Frontières

\# Developed in collaboration with the European Society of Intensive Care Medicine

et al. 2007). Students are expected to not only read the course manual but also to complete e-learning material, in the form of short narrated lectures, interactive lessons and formative assessment, before attending face-to-face small group teaching (Gomersall et al. 2010). The premise underlying this approach is that valuable teacher time is better spent on high-value small group teaching than on low-value lecturing (Schwartzstein and Roberts 2017). The saving in teacher time, as a result of the abolition of face-to-face lectures has allowed us to maintain small group teaching despite a 75% increase in class size—with only a minimal increase in resources. Surprisingly, student feedback indicates a preference for e-learning lectures over face to face. Students like the ability to listen to a lecture at a time that suits them and to replay segments of the lecture. While we believe that e-learning is essential in preparing students so that they achieve maximal benefit from small group teaching, e-learning alone may not have a significant effect on students' ability to manage clinical situations. We have shown that interactive electronic learning alone was not associated with improved medical student performance responding to scenario-based questions on managing mechanical ventilation, but the addition of just one hour of small group face-to-face teaching designed

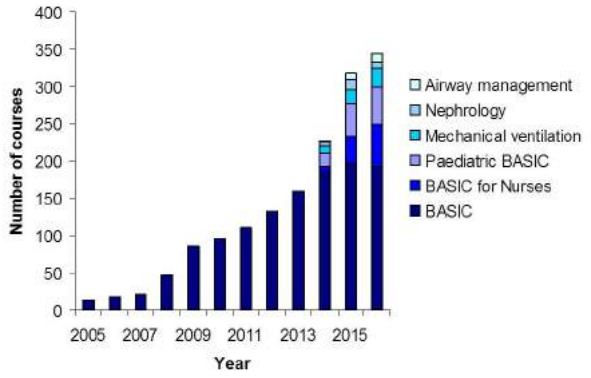

Figure 2. Selected BASIC Collaboration courses since 2005 – number of courses. Data for BASIC for Nurses, Paediatric BASIC and Beyond BASIC Mechanical Ventilation, Nephrology and Airway Management courses were only collected from 2014.

to reinforce application of knowledge was associated with a marked improvement (Leung et al. 2017).

"A FREE MOBILE APP TO SUPPORT THE BASIC COURSE HAS JUST BEEN INTRODUCED AND WE PLAN TO DEVELOP MOBILE APPS FOR ALL OF OUR COURSES"

Mobile apps

The Very BASIC course is supported by a free mobile app which facilitates quick retrieval of key information and also contains an electronic version of the course manual. The premise of the app is that medical students may not be able to rapidly recall information they have learned after they qualify but, if familiar with the app, will be able to find it rapidly when it is required. Once installed, the app can be used entirely offline, except to receive updates. This circumvents concerns regarding use in close proximity to key medical equipment and allows use of the app in clinical situations. Usage data from the app indicates that 30% of final year medical students continued to use the app following qualification (Leung et al. 2015; 2017). A free mobile app to support the BASIC course has just been introduced and we plan to develop mobile apps for all of our courses. Developing a mobile app for BASIC for Developing Healthcare Systems is a high priority. Costs of printing course manuals in low-income countries are high and may even match the disproportionately high cost of air freight to these countries. However, anecdotal evidence suggests that a high proportion of doctors in some low-income countries possess a smartphone or tablet, opening the possibility of using an app as an alternative to printed course manuals.

Conclusion

Training sufficient healthcare workers to provide high-quality care to critically ill patients across the globe is a major challenge. We believe that a collaborative approach utilising modern educational techniques and advances in mobile technology will facilitate attempts to meet that challenge. ■

Conflict of interest

Charles David Gomersall is the chair of the BASIC steering committee. Wai Tat Wong and Lowell Ling are instructors for the BASIC courses.

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Effective education for palliative care

Communication as a procedure

Palliative care for critically ill patients in the intensive care unit is increasingly in the mainstream, and palliative care principles are vital to ensure comprehensive patient care. *ICU Management & Practice* spoke to Caroline J. Hurd, MD, Director of Education Operations at UW Cambia Palliative Care Center of Excellence, about the purpose of palliative care education and ways to include the interprofessional team.

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Why do intensivists and critical care specialists need palliative care education?

What families will remember, long after their loved one dies, or survives the ICU, is not whether the central line was placed perfectly or a ventilator was titrated just right. They will remember the members on the healthcare team who had the best communication and supported their family during the most difficult moment of their life. When done poorly, this can worsen an already stressful situation, but when done well, people can view their ICU experience as meaningful. We are finally starting to think about communication skills in the ICU as a procedure that is just as important as hands-on procedural skills like central lines, intubations and thoracenteses.

Delivering serious news, facilitating a family conference, or providing anticipated guidance should be viewed as a set of defined, intentional skills, that can be improved with deliberate practice. At the Cambia Center we are building and integrating serious illness communication skills into our ICU rotations with a stepwise process that involves simulations, real-time observation and structured feedback, as we help learners through increasing levels of independence.

Why does palliative care education need to be interprofessional?

We do our best work when we work as a team. The ICU is a 24-hour environment that requires clinicians from all disciplines to contribute to whole-patient care. It is just not humanly possible for any one of us to be everything for each patient and their family. It is also inefficient and less effective for disciplines to work in isolation from one another. To give one example, our old model for ICU rounds was for the resident to present each patient, including overnight events and current clinical status. We realised that in doing this, the person most knowledgeable about these components, the nurse, was being sidelined, and key data was being omitted or was inaccurate. We now have our nurses present the patient data they collect as part of their routine assessment, residents present other diagnostic and exam data, both present insights from discussions with the patient and/or family and then together a plan of care for the day is created. We also find that relationships and rapport with families in the ICU is the key to continuity, trust and collaborative decision making. Sometimes the person who has the closest relationship with the family is the physician, while for other families that might be the chaplain or the social worker. If religious practice is central to this family's story, our chaplain may start a family conference with a prayer. This demonstrates mutual respect and alignment in a way that can set the stage for a healthy therapeutic alliance. For so long our disciplines have trained in parallel, but new training, with a focus on team communication and coordination, allows us to understand each other's strengths and best utilise our resources to benefit the patient and family.

What is an effective way to educate intensivists in palliative care consultations?

Effective education comes when facilitating communication is treated as a procedure (Whitaker et al. 2016). When interns start their one-month ICU rotation here at UW, the first day is a workshop on procedures. Half of the workshop is on leading a family conference, and half the workshop is on hands-on procedures. Combining these skills sends the message that these are equally important procedural skills for ICU clinicians. For the family conference curriculum, they start by completing a few short self-directed online modules. Then they practise during the workshop with trained actors using the VitalTalk evidence-based methodology for learning serious illness communication skills. They are then expected to do two of each procedure, including central line placement, thoracentesis, and observed family conferences during their 1-month rotation. Residents log these procedures, and their level of independence is assessed each week by an attending physician. We have also trained faculty to provide real-time observation and feedback to residents. The basics can be taught didactically, but this is reinforced with experiential learning. VitalTalk is a national model for small group serious illness communication. The pedagogy is about how small groups are facilitated and feedback given, with one of the most powerful components being labelling communication skills. This provides a common language and framework amongst learners and faculty. For example, the feedback might be: "the respect statement you used when talking to the patient's daughter de-escalated her anger." This helps learners identify skills they can translate to other settings. This training has shifted the whole culture in our ICU and raised the floor for everyone in serious illness communication skills.

Why is narrative important in palliative care?

One of my mentors, the late Stu Farber always said, "It is not our job to tell our patients' stories, it is our job to be good editors of their stories." Often the person's lived history is what is driving their decision-making. In my experience, conflict and moral distress, especially in the ICU, occur because we have not taken

the time to understand our patients' stories. One of the best examples of this was a woman with end-stage renal disease and dementia. Despite repeated hospitalisations for infections, progressive functional decline and critical illness, her daughter continued to request full medical treatment. Palliative care was consulted and one of our physicians elicited the patient's story. He found out that the patient, who was an African-American civil rights activist, had spent her life fighting for access to medical care. Her daughter could eloquently acknowledge that she would never want these interventions for herself, but she felt responsible to honour her mother's wishes of wanting all available medical treatment, even if this came at the cost of physical suffering. For the nurses and the care team, knowing about this patient's life history changed their lens; suddenly what was viewed as physical pain became meaningful. This appreciation changed every interaction with the family. We stopped trying to readdress code status each day and just walked with them in the journey. This new dynamic actually opened the space for her daughter to consider other options and the patient was transitioned to comfort care, dying shortly after. Knowing narrative is what creates the opportunity for alignment and shared goals.

How are patients and families educated about palliative care?

What is exciting about the field of palliative care is that education to the public is happening at many levels, and the messaging that palliative care is about goal-concordant care that aligns with values, as opposed to only a focus on end-of-life care, has been central to its dissemination. We are starting to normalise conversations about advance care planning, serious illness and challenging the status quo of our broken healthcare systems. A huge credit goes to organisations like the Center to Advance Palliative Care (CAPC) and their national initiatives to increase access to palliative care through advertising campaigns, public service announcements, health policy and online resources like **getpalliativecare.org**. Other leaders, such as Ellen Goodman who started the conversation project (**theconversationproject.org**) are speaking directly to patients and families and meeting a deep need in our communities. Because of efforts on many levels, palliative care is being integrated and offered further upstream as just good medical care for patients with serious illness. In our health system, we are working on trigger tools and embedded models of palliative care to increase availability and exposure to patients and families. The common theme among all of these efforts is that palliative care is filling a large gap that has been palpable in our health systems for some time. Patients and families who receive palliative care immediately feel this gap being filled, and that one-on-one impact still remains the best resource for of education and awareness. ■

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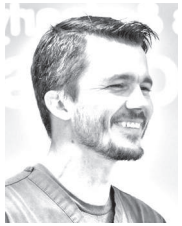
Free Open-Access Medical education (FOAM) and critical care

This article describes the nature of FOAM (Free Open-Access Medical education), its strengths and weaknesses, and how it can be used effectively by critical care clinicians, educators, and students.

"...and to teach them this art ó if they desire to learn it ó without fee and covenant."— excerpt from the Hippocratic Oath



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FOAM, or 'Free Open-Access Medical education', is not just social media. FOAM is a dynamic collection of online tools and resources, an ethos, and a thriving global interdisciplinary community of students and clinicians (Nickson and Cadogan 2014).

Rise of FOAM

The term 'FOAM' bubbled into existence as a reaction to social media's frivolous connotations in the minds of many doctors. Social media refers to the creation and exchange of user-generated content via virtual networks using internet applications (Nickson and Cadogan 2014). However, to many of us it is just YouTube videos of cute kittens, Tinder 'hook ups', and the 'alternative facts' of a post-truth Trumpian era. This prejudice prevents us from sharing ideas, disseminating and curating information, networking, and engaging with others using these tools. Which is why, so legend has it, my colleague Dr. Mike Cadogan stopped to drown his sorrows at a Dublin pub before speaking on this topic at the 2012 International Conference on Emergency Medicine (ICEM). Lo and behold, he found the answer at the bottom of a pint of Guinness and "FOAM" was born (Nickson and Cadogan 2014). Whatever you think of the term, it sticks in the mind and has helped the FOAM concept go viral. FOAM has grown rapidly since Mike's Dublin epiphany. There are now hundreds of blogs and podcasts using the FOAM banner in the critical care specialties (Cadogan 2016; Cadogan et al. 2014). Examples of useful critical care FOAM resources are featured in **Table 1**.

Aside from the multiplicity of available resources, there are numerous other indicators of the growing impact of FOAM. Page views and podcast downloads are surrogates for user engagement and, in some cases, indicate massive global consumption. For instance, the cumulative downloads of the *Social Media and Critical Care (SMACC)* podcast now exceed 2.5 million downloads and **Lifeinthefastlane.com** had 35 million page views over the past year. A controversial Social Media Index, analogous to a journal's impact factor, has even been created using social media metrics (Thoma et al. 2015). FOAM resources are becoming increasingly mainstream; some—such as *Academic Life in Emergency Medicine* and *Simulcast*—have developed collaborations with traditional medical journals (Academic Life in Emergency Medicine 2017; Brazil 2017), and many journals, including the *New England Journal of Medicine* (New England Journal of Medicine 2017), now have their own free-to-access blogs and podcasts. Furthermore, some colleges and professional bodies, such as the Australasian College for Emergency Medicine (ACEM CPD Committee 2017), now allow the use of FOAM resources for continuing professional development (CPD). Digital and social media scholarship is recognised by the Mayo Clinic for academic promotion and tenure (Cabrera 2017), and some institutions have incorporated FOAM resources into their training programmes; examples include the *Maryland Critical Care Project* and the Alfred Intensive Care Unit's *INTENSIVE* website. FOAM resources, especially critical appraisal websites like *The Bottom Line* and *Critical Care Reviews*, are also part of an emerging post-publication peer review paradigm for published research. There are even instances of FOAM blog posts leading to corrections in major medical journals (Intensive Care Network 2013). Unfortunately, although anecdotes about the benefits of FOAM for learning and improving patient care abound, there is still no research that establishes the benefits (or harms) of FOAM.

"PART OF AN EMERGING POST-PUBLICATION PEER REVIEW PARADIGM FOR PUBLISHED RESEARCH"

All a Twitter about FOAM

Despite the derision, social media is a potent catalyst for disseminating FOAM resources. Twitter, perhaps surprisingly, has had a central role. Twitter is free to use and allows people with useful ideas or content to be selectively followed. It also allows those who 'blow too much hot air' and anyone who behaves badly to be selectively unfollowed and blocked. Tweets are, notoriously, limited to just 140 characters. Yet this forced brevity is often a boon as it ensures users must be concise and efficient when communicating. The key to using Twitter effectively is to create a personal learning network out of trusted individuals who act as filters for information (Ankel and Swaminathan 2015). When this is not done, filter failure occurs, leading to information overload as the signal becomes swamped by noise (Nickson 2015).

Table 1. A selection of useful critical care FOAM resources

Critical Care Reviews http://criticalcarereviews.com	An extensive resource that includes newsletters, videos, and curated collections of research articles created by Rob Mac Sweeney.
Deranged Physiology http://DerangedPhysiology.com	Alex Yartsev's extensively researched website targeted at preparation for the College of Intensive Care Medicine's Second Part Exam.
Emcrit.org http://emcrit.org	A high impact blog and podcast created by Scott Weingart, with a focus on resuscitation and emergency department critical care.
Essential Critical Care http://www.essentialcriticalcare.com	Interview-based podcasts covering all aspects of intensive care by Todd Fraser. Includes podcasts from the Society for Critical Care Medicine (SCCM).
ICM Case Summaries https://icmcasesummaries.com	A blog that features expanded case summaries created by intensive care trainees in the United Kingdom.
ICS blog https://blog.ics.ac.uk	The blog of the United Kingdom's Intensive Care Society, including news, opinions, and events.
INTENSIVE http://intensiveblog.com	An education and knowledge translation blog and podcast provided by the Alfred intensive care unit. Key topics include extracorporeal membrane oxygenation (ECMO) and simulation resources.
Intensive Care Network https://intensivecarenetwork.com	Diverse podcasts, blogs, and other resources from the Australasian-based Intensive Care Network.
International Fluid Academy http://www.fluidacademy.org	An extensive multimedia resource created by Manu Malbrain on all aspects of fluid therapy in the critically ill.
Life in the Fast lane http://lifeinthefastlane.com	A comprehensive emergency medicine and critical care website featuring blogs, podcasts, an ECG Library, the Critical Care Compendium, and numerous curated resources.
Maryland CC Project http://maryland.ccproject.com	High quality video lectures from the University of Maryland critical care residency programme.
Mastering Intensive Care http://masteringintensivecare.libsyn.com	A podcast, created by Andrew Davies, comprised of interviews with intensive care leaders discussing non-technical skills, wellbeing and creating productive, sustainable careers.
PulmCCM.org http://pulmccm.org	A comprehensive multi-author pulmonary critical care blog that includes research updates and topic reviews.
ScanCrit http://www.scancrit.com	Thomas Dolven's and Daniel Kornhall's blog on critical care from a Scandinavian perspecitive.
SMACC (Social Media and Critical Care) http://www.smacc.net.au	Free-to-access audio and video podcasts from the SMACC series of conferences.
The Bottom Line http://www.thebottomline.org.uk	A website with multinational contributors featuring peer-reviewed critical appraisals of important critical care research.
Women in Intensive Care Network http://www.womenintensive.org	The website of the Women in Intensive Care Medicine Network, which is dedicated to improving the gender balance in Australasian intensive care medicine through advocacy, research and networking.

Twitter users can also follow topics rather than individuals when tweets are labelled with a hashtag. Thus FOAM tweets can be found by searching for the #FOAMed hashtag (not #FOAM, which seems to be used to tag tweets involving partying teens in rooms filled with bubbles). In addition to #FOAMed, there are now 'subspecialty' FOAM hashtags such as #FOAMcc (critical care), #FOANed (nursing education), #FOAMus (ultrasound), and #FOAMsim (simulation-based education), to name a few.

Twitter does have limitations, however. In particular, the medium is poorly suited to meaningful conversation and is even worse for attempts at reasoned argument. It turns out that the telephone and even good old-fashioned face-to-face communication still have their place!

FOAM community and ethos

FOAM resources are easily shared between users, who can interact freely with resource creators. A lively global interdisciplinary community has emerged from these activities (**Table 2** lists ten tips for getting involved). Evidence that FOAM truly is a community of practice comes from network centrality analysis of FOAM Twitter users (Roland et al. 2017). This virtual community reinforces a very real physical community, and vice versa, creating a virtuous cycle. This was the aim of the *SMACC* conference, for example, which provides a face-to-face meeting for an online community, "like a reunion with friends we never met" (Nickson 2013). Iterative virtual and face-to-face interactions within the FOAM community have led to numerous collaborations and 'real-world' opportunities for those willing to embrace them.

Ultimately, the FOAM community is united by the ethos that high-quality medical education resources and interactions should be free and accessible to everyone in healthcare (Nickson and Cadogan 2014). The movement's ongoing success—despite a lack of traditional motivators such as academic status or financial reward—has grown from open sharing, collaboration, and the attribution and recognition of the work of others (Nickson and Cadogan 2014).

All healthcare professionals must maintain their professionalism when using social media, whether or not they are involved in FOAM.

Table 2. Ten tips for FOAM beginners (Nickson 2017)

1. Sign up to Twitter
2. Register as a FOAM user
3. Be identifiable, don't be anonymous
4. Be professional
5. Be active—don't let anyone be wrong on the Internet!
6. Be generous with your criticism and with what you share
7. The more you put in, the more you get out
8. Use the key FOAM resources mentioned in this article to get started
9. Use filters to beat information overload, and be a filter yourself
10. Have fun and don't take it too seriously!

The amplifying nature of social media means that indiscretions tend to be magnified and may even echo in eternity. Anonymity online offers little protection, as real identities are usually discoverable. Best practice for health professionals active in social media is to avoid anonymity (General Medical Council 2013). Finally, in FOAM, patients should always come first and patient confidentiality is sacrosanct.

FOAM is a useful adjunct for education

FOAM does not replace existing approaches to medical education. On the contrary, FOAM supplements and complements other effective educational strategies. There is a danger that unguided learners that lack the background knowledge or clinical experience to appreciate the context and nuances of FOAM resources may go astray. For this reason, the bedside mentor is still a necessity.

Education does not happen unless learners are engaged, and social media is increasingly where the learners are (Mallin et al. 2014). Social media interactions facilitate peer-assisted learning within virtual communities of practice (Roland et al. 2017). Researchers, educators and organisations hoping to close the knowledge-translation gap between research and clinical practice need to engage these communities (Young et al. 2013). However, early adoption also carries the risk of new unvalidated research being put into practice too early (Young et al. 2013). An educated, critical thinking community that is willing to speak up may help mitigate this risk, a goal exemplified by the *Skeptics Guide to Emergency Medicine (SGEM)* podcast on the Vitamin C cocktail for sepsis (Skeptics Guide to Emergency Medicine 2017).

FOAM resources have applications beyond self-directed learning and peer-assisted learning. Teachers can leverage the engagement of FOAM resources by using them to trigger group discussions and to foster critical thinking skills when appraising information sources. Such guidance helps learners put information in context, so they can understand how it is used in different settings and by clinicians of varying expertise. One useful strategy is the use of 'FOAM prescriptions' to consolidate bedside learning (Carley 2016).

The integration of FOAM resources as reusable learning objects (RLOs) within training programmes has other advantages. They can be used for pre-learning to allow time and space for interactive group sessions rather than didactic lectures, as part of a 'flipped classroom' (Prober and Heath 2013). They allow learners to benefit even when they cannot attend face-to-face teaching sessions at the same time (asynchronous learning). Finally, concise and accessible FOAM resources are well suited to 'just-in-time' knowledge delivery (Davenport and Glaser 2002). For example, the Alfred Intensive Care Unit has created FOAM resources with this purpose for tasks such as priming an ECMO circuit (Anderson 2016).

FOAM resources also fill a niche by allowing tacit knowledge sharing (Panahi et al. 2015). Experiential 'know how' that is often neglected by textbooks and research articles can be shared and discussed using FOAM. This includes practical 'on-the-job' solutions that can be adapted for local use. However, there is a danger that trainees may adopt techniques that are untested or beyond their level of expertise. Which is why, once again, FOAM is just an adjunct to, and not a replacement of, the bedside mentor.

The FOAM quality conundrum

Common criticisms of FOAM are that it lacks peer review and that the quality is variable and unregulated. Many FOAM resources do have these limitations, yet we must not throw out the baby with the bathwater. After all, traditional peer review has many well-documented flaws and is a tarnished gold standard (Smith 2006). Yet we do not dismiss all peer-reviewed research just because peer review has limitations, nor

Table 3. An eight-step approach for assessing the quality of a FOAM resource (Nickson 2017)

Step	*Comments*
Is the author identifiable?	As a rule of thumb, anonymous sources of information should be disregarded.
What are the author's qualifications?	This does not mean a student's blog should be ignored, but knowledge of expertise and experience helps put it in context. At the other extreme, we must beware of 'Arguments from Authority' that lack any other basis.
Are there conflicts of interest?	Beware of financial conflicts of interest in particular, especially Big Pharma's influence on published medical research.
Does what I know check out?	Be reassured if the author's work on other topics that you have expertise in was accurate – however, be wary of ultra-crepidarians: an expert in one sphere is not necessarily an expert in another!
Is it logical?	Is the information logically coherent? Does it make sense? Does the author commit logical fallacies?
Is it referenced?	Claims should be referenced appropriately so they can be verified.
Is it supported by trusted recommendations?	Do other people I trust rate the resource highly?
How does the author respond to criticism?	No one is right all the time – be reassured by authors that respond to constructive feedback openly and are willing to make improvements as part of a post-publication peer review process.

because most published research findings are false (Ioannidis 2005), nor because high-profile research findings are commonly contradicted by subsequent, superior studies—a phenomenon termed 'medical reversal' (Prasad et al. 2013).

The accuracy of FOAM resources is yet to be formally studied, although Wikipedia sets a precedent, proving that online resources created by volunteers can match the veracity of established resources produced by professionals (Giles 2005). Nevertheless, it is inevitable—through human error or the progress of time—that inaccuracies will be found in FOAM resources. Their impact may be mitigated by the existence of an active FOAM community that promotes rapid correction through post-publication peer review.

Information, regardless of the source, can be wrong. As health professionals we must develop the critical thinking skills needed to accurately appraise information from any source. **Table 3** highlights an eight-step approach to judging the quality of FOAM resources, and similar quality indicators have been identified by Lin et al. (2015).

Conclusion

FOAM is a dynamic collection of free-to-access online medical education resources, from which a vibrant learning community united by an ethos of sharing has grown. FOAM is an exciting adjunct to established educational strategies and promotes engagement, knowledge dissemination, networking and collaboration. FOAM, however, does have limitations. Resources must always be critically appraised to determine their quality, and students still need guidance from their teachers. For this reason, clinician educators need to be aware of the available FOAM resources and their pros and cons. Despite the challenges, FOAM continues to evolve and has considerable scope to benefit health professionals and their patients. ■

Conflict of interest

The author has no financial conflicts of interest. He is co-creator of the following FOAM projects: Life in the Fast lane (**http://lifeinthefastlane.com**), SMACC (**http://smacc.com.au**), INTENSIVE (**http://intensiveblog.com**), and the Resuscitationist's Awesome Guide to Everything (**http://ragepodcast.com**).

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Physiotherapy in the ICU e-learning programme

Development and evaluation of a module as part of an undergraduate international honours degree programme

Preparing undergraduate students for the complex and daunting environment of the intensive care unit (ICU) is difficult for most undergraduate programmes. The European School of Physiotherapy, Amsterdam University of Applied Sciences, offers an international undergraduate programme for students preparing to work anywhere in the world. To prepare these students for ICU, the ICU course includes, besides a clinical rotation, an evidence-based e-learning module. Students and international ICU clinicians helped evaluate the content and didactics of the module. This article reports on the development and results of the first round of this evaluation.

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Physiotherapy practice in the intensive care unit (ICU) requires highly specialist skills and knowledge, but no specific requirements are described in the physiotherapeutic competence profile (Gosselink et al. 2008). Recently, several initiatives have been developed and published with the aim to establish minimum clinical standards for the ICU physiotherapist (Skinner et al. 2016; Van Aswegen et al. 2017; Hanekom et al. 2015). However, as yet, no formal postgraduate training is required or available for physiotherapists (PTs) starting to work in ICU. Undergraduate programmes are expected to prepare graduates for any clinical environment, including the complex ICU setting. The undergraduate programme of the European School of Physiotherapy (ESP) is an international BSc (Hons) programme as part of the Amsterdam University of Applied Sciences in Amsterdam, the Netherlands. Currently students from 42 nationalities are enrolled in the programme. The majority of the students will return to work in their home country after graduation. It is the aim of the programme to prepare graduates as much as possible for clinical work in any international environment. This poses challenges as well, as clinical ICU work and expectations of the physiotherapist in ICU, for example, differ per country and sometimes even per hospital.

Such expectations consist generally of having a strong theoretical foundation, awareness of safety criteria, possessing skills and knowledge with regards to ICU-specific physiotherapeutic assessment and interventions, and having had practical experience. To provide students with skills and knowledge required for working in intensive care, an ICU course was added in 2016 as a compulsory part of our undergraduate programme. We developed an evidence-based e-learning module as a prerequisite for the student's clinical rotation.

The aim of the project described here was to evaluate the feasibility of e-learning as a teaching method and students' satisfaction with the content and user-friendliness of the ICU e-learning module.

Development of the module

The e-learning module was developed in close collaboration with clinical and research experts of the rehabilitation department of the Academic Medical Center (AMC) in Amsterdam. The ICU department in the AMC is the location where most of the course's videos were taped. The module was piloted among a group of students, didactic and clinical experts during two 6-week periods in 2015 and 2016. Feedback was used for a final revision to the module, before incorporation in the curriculum.

> "EVIDENCE-BASED E-LEARNING MODULE AS A PREREQUISITE FOR THE STUDENT'S CLINICAL ROTATION"

Content of the e-learning module

The e-learning consists of 7 modules, related to the general environment of ICU and specific ICU equipment, impact of ICU stay on the patient and family, physiotherapy assessment and interventions, and multidisciplinary collaboration. Through a variety of teaching methods, such as interactive assignments, videos, scientific articles and quizzes the content is brought to the students in a 6-week online course.

Methods of evaluation

The e-learning module's evaluation forms part of a larger PhD research project on rehabilitation after critical illness. Several groups of ESP students conducted their bachelor thesis research within this PhD research project.

In a first round of evaluations (during September-December 2016), when the module was piloted, focus

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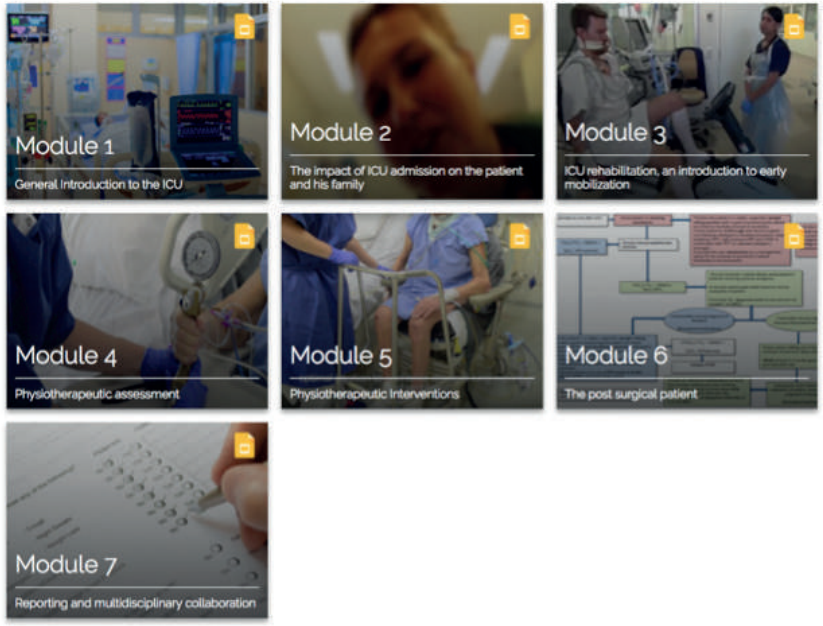

Figure 1. Overview modules e-learning 'Physiotherapy in the ICU'

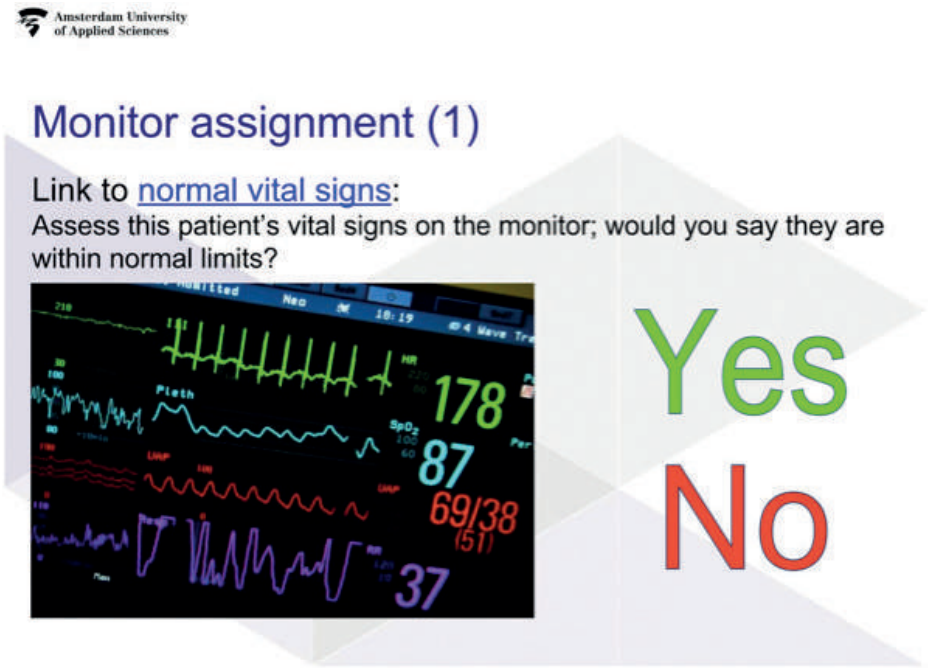

Figure 2. Example assignment

"FEASIBLE METHOD TO PROVIDE STUDENTS WITH THE BASIC KNOWLEDGE, SKILLS AND CLINICAL REASONING REQUIRED FOR A CLINICAL ROTATION IN THE ICU SETTING"

group meetings and semi-structured interviews were held to obtain information on usefulness and user-friendliness of the e-learning. The written test was analysed for constructive alignment with the course objectives.

Results

Undergraduate students evaluated the ICU e-learning's content as very positive and an important contribution to the existing curriculum. Students highlighted the value of the practical videos taped in the ICU department of the AMC as well as the interactive and the diverse assignments.

Students felt that the content of the e-learning prepared them sufficiently for the physiotherapeutic tasks expected of students during their clinical rotation in ICU, as well as the assessment of safety criteria for early mobilisation (Sommers et al. 2015).

Analysis of the exam questions and results led to revision of the exam, with a larger focus on the application of clinical reasoning skills.

The feedback rounds resulted in many suggestions regarding user-friendliness of the e-learning environment and technical problems encountered during the pilot phase. This resulted in major technical revisions to the module.

Further development

In a second round of evaluations (during September-December 2017), focus group meetings with students

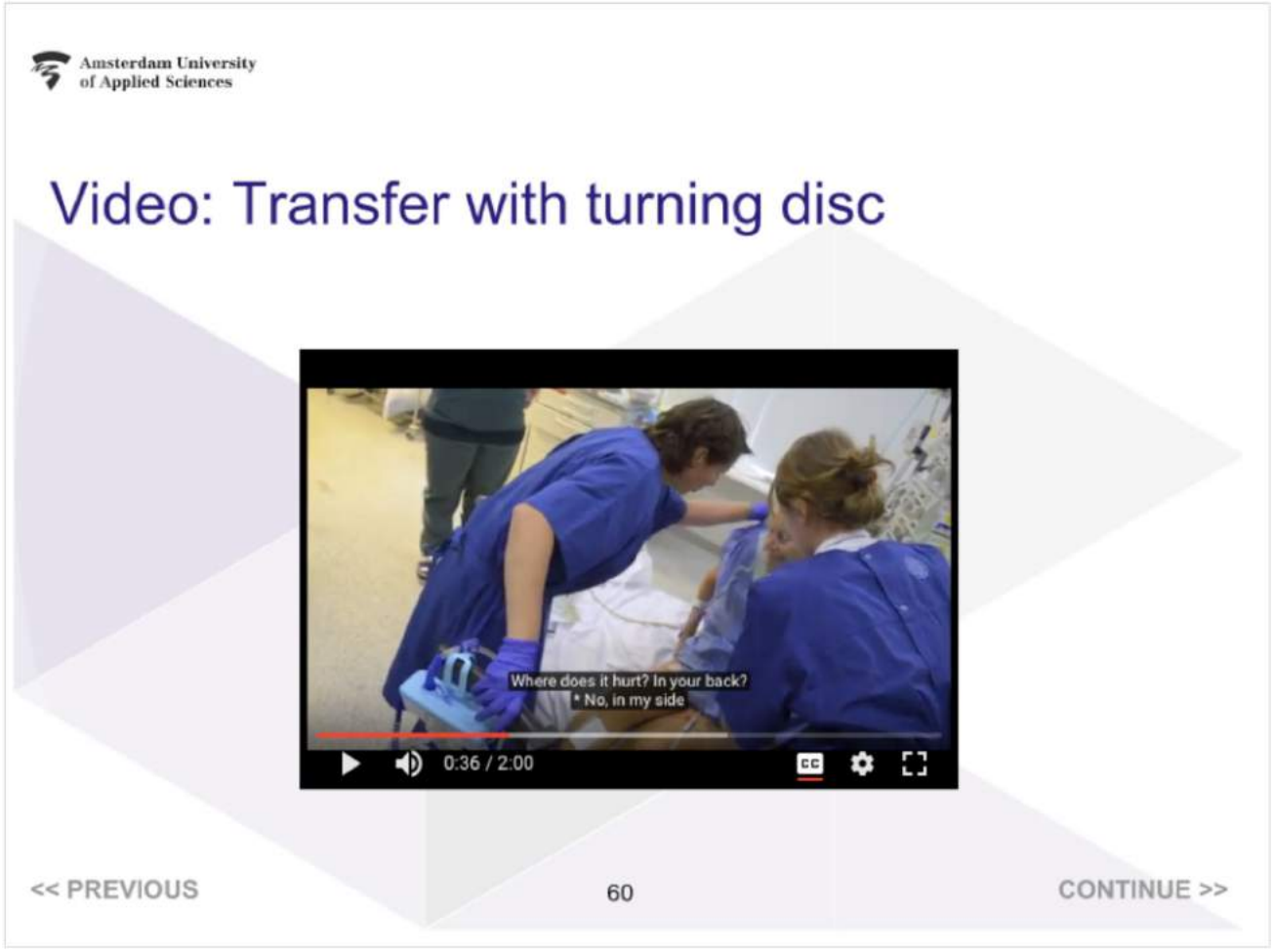

Figure 3. Example video

who completed both the theoretical (e-learning) as well as the practical part of the ICU course will be conducted. Interview rounds with ICU clinicians from several international and ICU settings will be planned. Whereas the focus for the first round of evaluations was on evaluation of user-friendliness and accessibility of the module, the second round evaluation's focus is on appropriateness and completeness of the content with regards to the (international) ICU environment. Based on results of these evaluations the e-learning module will be adjusted.

Conclusion

Our study concludes that an e-learning module on physiotherapy in the ICU is a feasible method to provide students with the basic knowledge, skills and clinical reasoning required for a clinical rotation in the ICU setting.

The e-learning is meant to be complementary to the practical observation and as such the content is found very useful for students just before or during their clinical rotation. ■

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Benefits of CRM education and simulation in intensive care and emergency medicine

First developed in aviation, CRM education facilitates prevention of accidents in medicine. Beyond the improvement of technical skills, the simulation can provide to learners the capacity to work with other team members, to pay attention to the work environment and to manage physiological or psychological constraints in critical situations

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Activity in intensive care and emergency medicine

Intensive care and emergency medicine are high risk departments where critical decisions and procedures are performed by multidisciplinary teams on vulnerable patients. Patients in the intensive care unit frequently suffer from multiple organ dysfunction that requires invasive support and multiple intravenous medications with rapid response rates required. Errors in such frail patients have a major impact on morbidity and mortality with an estimated 100,000 deaths each year in the U.S. due to medical errors (Kohn et al. 2000). Emergency and intensive care units teams have irregular working patterns, with long working hours and night shifts at irregular intervals. They are therefore frequently exposed to stress and fatigue. The skills required to deliver quality of care can be differentiated into technical and non-technical skills (NTS), both playing a crucial role in patient safety (Flin et al. 2008).

Technical skills are generally taught and assessed properly in physicians' training with overall good performance. Non-technical (social and cognitive) skills, on the other hand, suffer from lack of recognition and training in most countries. Deficiency in non-technical skills is often implicated in the occurrence of medical errors and serious adverse events (Catchpole et al. 2006). The development of simulation with high-fidelity human mannequins has transformed evaluation and training of non-technical skills with dedicated scales and specific simulation-based training programmes. Such programmes, derived from the aviation industry, are called crew resource management (CRM) training.

CRM education

CRM (Crew Resource Management[1]) training was first used by civil aviation after many deadly accidents in the 1970s (e.g. Tenerife airport disaster that killed 583 people). Lauber (1984) defines CRM as "using all the available resources (information, equipment and other people), to achieve safe and efficient flight operation". The main objective of CRM is to reduce accidents derived from human errors. To explain the increase of accidents in the aviation industry, we can enumerate the introduction of technology in the human activity (e.g. augmentation of complexity; Hollnagel 1991), and also the impact of human collaboration (e.g. communication between the exterior and interior of the cockpit or within the crew). In the literature, two concepts were identified to illustrate the human skills during their activities, namely technical skills (also named hard skills) and non-technical skills (also named soft skills). For Flin and colleagues (2003), the concept of non-technical skills includes cognitive skills (cooperation, leadership and managerial skills) and social skills (situation awareness and decision making), as being a complement of workers' technical skills. In medicine, medical errors are the third leading cause of death in the U.S. (Makary and Daniel 2016). The notion of error is quite complex (Reason 1990; Amalberti 2013), but we can consider that it contributes to accidents. For St Pierre, Hofinger and Buerschaper (2008), critical situations provoke errors, which can even lead to accidents. Flin and colleagues (2003) created a taxonomy, named NOTECHS (NOn-TECHnical Skills) to evaluate the good and bad practices of NTS in aviation. This work has been translated to surgery to design an evaluation scale of NTS in the teamwork operating theatre (Sevdalis et al. 2008). Many methods emerge from the medical domain to evaluate NTS in different specialities like anaesthesia (Fletcher et al. 2003). The objective of these methods is to evaluate the capacity of practitioners: (1) to work with the other membership or colleagues (e.g. communication or leadership), (2) to pay attention to the work environment (e.g. situation awareness) and (3) to manage physiological or psychological constraints (e.g. stress or fatigue). In their book *Safety at the sharp end*, Flin, O'Connor and Crichton (2008) formulated NTS into seven skills: situation awareness, decision making, communication, teamwork, leadership, managing stress and coping with fatigue. For them, NTS represent cognitive, social and personal resources skills that complement technical skills and contribute to safe and efficient task performance. Indeed, the deficiency of technical knowledge is not enough to explain the occurrence of accidents. For example, the analysis of the case of Elaine Bromiley (Reid and Bromiley

1The first denomination was cockpit resource management used in 1979 in the NASA conference (Cooper et al. 1980).

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2012) revealed a deficit in situation awareness and some wrong communication between the membership of the medical team, which led to bad decisions and the death of the patient. At the beginning of the 1990s, the crew resource management of aviation became crisis resource management for healthcare professionals, especially through the work of Gaba in anaesthesia (Gaba et al. 2001).

"HIGH-FIDELITY SIMULATION REMAINS THE MOST COMPREHENSIVE TO TRAIN NON-TECHNICAL SKILLS"

Advantages of simulation

In the medical domain, simulation is defined as the

> *use of a device, such as a mannequin, a task trainer, virtual reality, or a standardized patient, to emulate a real device, patient, or patient care situation or environment to teach therapeutic and diagnostic procedures, processes, medical concepts, and decision making to a health care professional.* [2]

Alinier (2007) classified different types of simulation. He delimited 6 levels of simulation teaching, from basic knowledge/no technology (pen and paper simulation; Level 0) to high knowledge and practice/advanced technology (high-fidelity simulation; Level 5, see **Figure 1**). High-fidelity simulation remains the most comprehensive to train non-technical skills, but learners need to have enough theoretical and procedural background knowledge to be effective. So, these different kinds of simulation should not be seen as opposed but complementary. Some bring knowledge (e.g. low-fidelity mannequin, software), others provide procedural know-how (e.g. high-fidelity simulation).

At the end of the 1980s, Gaba and DeAnda (1988) developed a simulator in a real operating room to investigate decision making and human performance during critical situations in anaesthesia. This kind of simulation challenges technical skills but also non-technical skills (e.g. I stay calm in crises, I focus on priorities, I assume the role of team leader, etc.;) (Holzman et al. 1995). Among many advantages (see Cook et al. 2011), the simulation reduces errors and improves patient safety (Salas et al. 2005). Learners increase autonomy and self-confidence when delivering patient care after practising first with high-fidelity patient simulators (Peteani 2004). Recent technological advances allow learners to carry out interventions on high-fidelity mannequins (Maran and Glavin 2003; Cooper and Taqueti 2008), especially in intensive care (Campbell et al. 2009) or emergency medicine (Small et al. 1999). CRM courses facilitate improvement of NTS such as team working, leadership, communication or managing stress (Coker and Kass 2006; Naik and Brien 2013). CRM learning should be designed for each activity with multiple working supports, including theoretical courses and simulations. Professions such as intensive care or emergency medicine include some critical situations that generate stress and challenges. Physicians must be prepared in order to anticipate problems and complications with adequate communication (e.g. accurate, cordial), leadership/team working (e.g. role distribution),

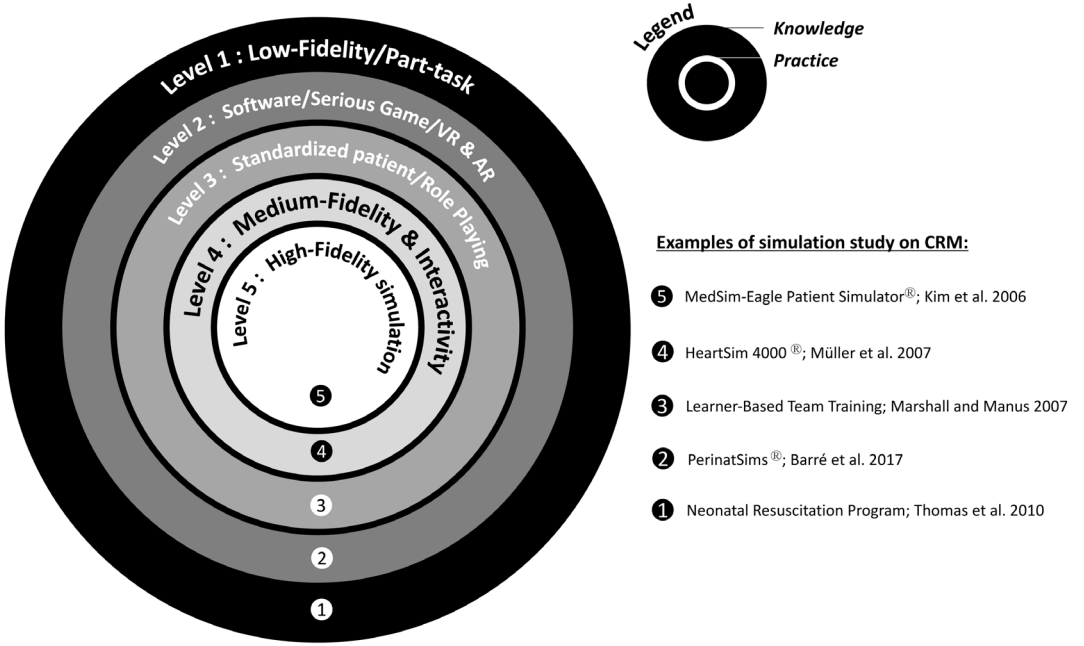

Figure 1. Classification of simulation (adapted from Alinier 2007), including examples of study focused on CRM Education in intensive care, emergency medicine and anaesthesia

[2] H.R. 855 To amend the Public Health Service Act to authorize medical simulation enhancement programs, and for other purposes. 111th Congress, USA, 2009. Available from: gpo.gov/fdsys/pkg/BILLS-111hr855ih/pdf/BILLS-111hr855ih.pdf

situation awareness/decision making (e.g. avoid the tunnel effect) and to be preserved from emotional disorders. Apart from mannequin training (parts, low or high fidelity), we can mention the importance of advanced software in medicine. Computer-based applications are increasingly used to support learning in medicine. The technological improvement of virtual environments, virtual reality, and augmented reality creates an expansion of use in the medical domain (Barsom et al. 2016). For example, serious games have emerged in health professional training (Drummond et al. 2017), as in cardiopulmonary resuscitation thematic applications like *CPR simulator* or *Staying Alive* (see Wattanasoontorn et al. 2013). Some serious games can be used in CRM education (Barré et al. 2017). In this last study (ongoing project), the authors are improving NTS physicians' learning in postpartum haemorrhage (PPH) situation with *PerinatSims* software.

Perspectives

In this paper, we highlighted that education and teaching of CRM in medicine, mainly in critical situations, helps to reduce errors and accidents. Simulation is a virtuous circle for CRM; it provides evaluation of the skills of professionals (Kim et al. 2006) and at the same time improvement by training (at the end of evaluation a debriefing with the learners capitalises on the knowledge and the know-how). Simulation may improve specific NTS, such as communication (e.g. role playing), situation awareness or decision-making (e.g. serious game), but can also simulate situations that challenge all NTS (e.g. high-fidelity). ■

Conflict of interest

Jessy Barré declares that he has no conflict of interest. Arthur Neuschwander declares that he has no conflict of interest. Antoine Tesniere declares that he has no conflict of interest

Abbreviations

CRM crew/crisis resource management

NTS non-technical skills

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Molecular diagnostics in respiratory virus infection

Recent trends in virus detection assays and host response biomarkers

This article provides an overview of the recent advances in molecular testing for patients with suspected respiratory tract infection.

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Respiratory tract infections are common reasons for admission to intensive care units. For decades conventional culture techniques were the gold standard for establishing the aetiology of the respiratory tract infection. Data generated by these techniques had led to the general belief that bacteria are the most common pathogens in respiratory tract infection. However, a large shift in our thinking on the aetiology of respiratory tract infection has occurred in recent years. This shift is facilitated by the emergence of new data from epidemiological studies and is further propelled by a rapid technological advance in molecular testing, as explained below.

New evidence from epidemiological studies

Recent epidemiological studies show that respiratory viruses are the most commonly identified cause of community-acquired pneumonia. In the EPIC study, a large-scale prospective study of an adult U.S. population, researchers found that the incidence of virus-related community-acquired pneumonia (23%) was significantly higher than bacteria-related community-acquired pneumonia (11%) (Jain et al. 2015). The most common pathogens are rhinovirus (9%) and influenza virus (6%), with Streptococcus pneumoniae (5%) being the third most common pathogen. Other respiratory viruses are also common among patients with pneumonia, including metapneumovirus, parainfluenza virus, respiratory syncytial virus, coronavirus and adenovirus. Similarly, in a recent meta-analysis respiratory viruses were found to account for 29% of pneumonia cases (Burk et al. 2016). Furthermore, the incidence of viral infection was even higher (44.2%) when the sampling methods included both upper and lower respiratory tract samples, suggesting that the true incidences of respiratory virus infection were most likely underestimated in a majority of studies (Burk et al. 2016). Altogether this evidence challenges the traditional paradigm that bacteria are the most common cause of community-acquired pneumonia.

Technological advance in virus testing

Previously, conventional culture techniques were used to detect common respiratory pathogens. These techniques, insensitive for the detection of viral pathogens, have generated the bacteria-centric view of respiratory tract infection. However, the emergence of novel technology in nucleic acid amplification and multiplex technology has radically changed the diagnostics landscape. New applications of these technologies, such as point-of-care multiplex polymerase chain reaction (PCR) assays, have made it relatively easy and economically viable to test for respiratory viruses in any patients with respiratory symptoms (Chen et al. 2017). It is now possible to detect a wide range of bacterial and viral pathogens in a single sample and the results can be available in just over one hour (Esposito and Principi 2017). Increasing adoption of this point-of-care technology has resulted in an increase in the reported incidences of virus-related respiratory tract infections. This in turn has expanded our understanding of the aetiology of respiratory tract infections.

Evidence supporting point-of-care virus testing

The increasing awareness of respiratory viruses in the aetiology of community-acquired pneumonia, combined with rapid advances in diagnostic technology and molecular testing, have reshaped our thinking and approach to the management of severe respiratory tract infections. The new molecular tools also facilitate the better management of patients with suspected infection. As shown in a recent randomised trial, the early detection of a respiratory virus by point-of-care multiplex PCR assay has led to the more timely implementation of infection control measures (prompted by a faster reporting of virus-positive patients), a shortened course of antibiotics and a decrease in the indiscriminate/non-selective use of antiviral therapy (Brendish et al. 2017).

"HOST RESPONSE BIOMARKERS MAY SERVE AS A CANARY IN THE COALMINE EVEN IN THE ABSENCE OF VIRUS DETECTION"

Caveats in virus detection assay

These new diagnostic technologies have a focus on "virus detection", and as such the clinician needs to be aware of the significant drawbacks when applying these assays to patient care. The identification of a virus is an important part of the diagnostic workup. However, without corroborating information on the host response, virus detection by itself has a number of limitations:

(1) *"Detection" does not necessarily mean "infection"*

Many respiratory viruses detected in virus detection assays are also found in the respiratory tract of healthy humans who do not have symptoms (Hayward et al. 2014; Heinonen et al. 2016). Therefore, the mere presence of a virus in a symptomatic patient does not necessarily mean that the virus is causally related to the presenting illness. For example, both rhinovirus and influenza virus are found in individuals who have no symptoms, as well as those with severe symptoms (Hayward et al. 2014; Heinonen et al. 2016).

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(2) Viral load correlates poorly with risk of deterioration

Viral load in the airway does not always correlate with the clinical course of the illness. Patients with a low viral load could have a poor clinical outcome; conversely, patients with a high viral load may not develop a severe illness. It has been postulated that the virus causes the initial local damage in the respiratory tissue, but the subsequent host response triggered by the virus seems to run its own course, independent of the initial virus load (Oshansky et al. 2014).

(3) Transmissibility does not equate to virus replication

The detection of fragments or part of the virus particle usually confirms that the host has been exposed to the virus. However, clinicians should be aware that non-viable virus, dead virus or fragments left behind by a previously active virus can also lead to a "positive" detection test. Detecting fragments of the virus particle (e.g. RNA or antigen) merely indicates the presence of the "footprint" of the virus. Although this confirms that the virus has been transmitted to the host, it does not necessarily mean that the virus is actively replicating, which is an essential prerequisite for tissue injury.

Host response biomarkers as novel diagnostics

Host response biomarkers could provide additional diagnostic information and help address the limitations of the virus detection assays described above. These biomarkers provide diagnostic information on the state of the activated immune cells and therefore could provide an important link between virus detection and the biology of the host response. The host response of respiratory virus infection typically begins with local tissue injury caused by the invading virus. Soon after this initial event, the viruses set off a chain of downstream immunological events, which, in some individuals, results in disease progression and severe lung injury. This systemic immune response is detectable in the peripheral blood, as measured by the transcriptomic profiling of the peripheral blood ("blood transcriptome"). Recent meta-analysis has found that this transcriptome signature is present in the peripheral blood in most cases of severe respiratory virus infection (Andres-Terre et al. 2015). The clinical utility of using blood transcriptome to assist diagnosis has been recently validated in prospective studies (Tsalik et al. 2016; Zhai et al. 2015; Herberg et al. 2016). Furthermore, a study by Suarez et al. has shown that these transcriptomic biomarkers performed better than conventional biomarkers, such as procalcitonin, in identifying patients with a respiratory virus infection (Suarez et al. 2015).

Combined use of virus detection assay and host response biomarkers

In the future it is envisaged that transcriptomic biomarkers will be used, together with virus detection assay, in the routine diagnostic workup of patients with a suspected respiratory virus infection (Tang et al. 2017).This combined approach has advantages over using virus detection assay alone, as outlined below:

(1) Increased diagnostic yield

The new multiplex viral PCR assays are highly accurate in detecting common virus strains. However, this relies upon (1) an adequate sample of respiratory secretion obtained and (2) the sample is collected during the virus-shedding window. A number of factors could adversely affect this process. For example, viral shedding could be reduced by prior antiviral therapy or sampling could be incorrectly performed, both of which could reduce the sensitivity of the virus detection assay. The host response biomarkers may serve as a canary in the coalmine even in the absence of virus detection and prompt appropriate sampling/further investigations. Thus, the combined use of host response biomarkers and virus detection assay will identify additional cases that would have otherwise been missed by using virus detection assay alone.

(2) Risk stratification

Virus detection assay provides minimal information regarding the risk profile of the infected patient. Risk stratification is clinically important since it allows clinicians to determine which patients should be admitted to hospital or referred to an intensive care unit. Recent studies have shown that host response biomarkers detected in blood transcriptomes correlate well with infection severity in critically ill patients (Scicluna et al. 2017). In the event of a future influenza pandemic, the use of blood transcriptomic biomarkers may assist the triage of high-risk patients and the allocation of limited intensive care resources.

(3) Biomarker-guided immune therapy

Dysregulated host response is a key determinant of outcome in severe respiratory viral infection (Herold et al. 2015; Dash and Thomas 2015). Modulating the host response is currently an area of active research. Novel immune therapy could restore immune homeostasis and therefore halt the progression of severe disease in infected patients (Imai et al. 2016). Given the complexity of the immune response in viral infection, biomarkers are needed to guide the use of such therapy. With an increasing recognition that host response mediates immunopathology in severe respiratory tract infections (Dunning et al. 2014), we anticipate an acceleration of research in this field in the near future.

Conclusion

Future development in this field will most likely consist of the combined use of multiplex virus detection assay and host response biomarkers. With the widespread use of molecular testing in modern laboratories and an increasing recognition of the role of respiratory viruses, intensivists should be aware of the strengths as well as the limitations of these exciting new diagnostic technologies.

Conflict of interest

Benjamin Tang declares that he has no conflict of interest. Maryam Shojaei declares that she has no conflict of interest. Marek Nalos declares that he has no conflict of interest. Anthony McLean declares that he has no conflict of interest. ■

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Integration of nurse practitioners into the critical care team

A viable approach to meet pressing challenges

As the demands of critical care medicine increase one viable option to meet needs is the addition of a nurse practitioner to the traditional structure of the critical care team. The purpose of this article is to convey our positive experience of physician and nurse practitioner integration into the critical care setting.

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Critical care medicine remains a relatively young field, but remarkable strides have been made in diagnostics, interventions and technologic advances that have led to improved patient rescue. As our care has become more sophisticated and the field has grown, so have the numbers of patients receiving intensive care and the demands upon the caregivers. To meet ever increasing needs for efficacy and efficiency, modifications have been proposed (and in some cases implemented) to the traditional structure of the critical care team. Having gone through such an operational transition, we hope to convey our positive experience of physician and nurse practitioner integration into the critical care setting.

Rationale for revision

Intensivists now seem to be confronted by an ever increasing workload while being pulled in often competing directions. The number of critically ill patients continues to grow, as does the 'chronically critically ill' population. Demanding documentation requirements, tighter scheduling, unanticipated changes in patient status, constraints on house staff availability and duty hours, and lengthy bedside procedures can take time away from important care activities planned for the shift. The electronic medical record (EMR) has been instrumental in providing access to up-to-date data, but has also helped to physically disconnect the intensivist from patients, nurses and families as well as encouraged interruption of the needed face-to-face, short-loop feedback cycle of decision, assessment and adjustment. Adding to the complexity of the critical caregiving task are the oft-changing care guidelines, increased needs to assure safety, heightened attention to economics, and ongoing education needs. All vie for the physician's attention. Meanwhile a shortage of intensivist-trained physicians together with a high degree of burnout threatens to deplete the future workforce. How can one individual provider optimally meet patient care needs while maintaining job satisfaction within this environment? Medical complexity coupled with the potential for overextension ensures that certain aspects of patient care may be overlooked—intentionally or unintentionally. One tenable and cost-effective solution is to extend capability by collaborating with advanced practice nurses to ensure comprehensive care.

Background

The employment of advanced practice nurses, i.e. specialty-skilled nurse practitioners, within critical care began in the 1980s. More recently, intensive care units (ICUs) across the United States have increasingly been fashioning new positions or altering their treatment models to integrate such nurse practitioners into their interdisciplinary team approaches. Now more than 35% of all academic teaching institutions in the United States employ nurse practitioners (Gershengorn et al. 2012).

The models of employment differ widely and are customisable, but three main models have emerged:

1. In the first model, nurse practitioners (NPs) are assigned to a separate team that cares for patients in collaboration with an intensivist.
2. In the second model, NPs and house staff are combined into one team whose responsibilities overlap.
3. The third model uses a nurse practitioner as an overseer who helps manage and delegate the components of care.

These models leave ample room for overlap and flexibility. Because these specialty-focused nurses have extensive time and training in hands-on delivery of care, they are usually sensitive to the patient needs, to the demands of family, to the requirements to fulfil orders, to practical limitations, and to the discomfort to the patient imposed by management plans. Recent emphasis on 'complete' patient-centred care makes natural the integration of physician and nurse practitioners, wherein the nurse practitioner becomes a valuable resource for house staff and other members of the interdisciplinary team, often acting as a sounding board and second opinion provider for the intensivist.

The role for acute care nurse practitioners in the ICU may involve implementing the day-to-day treatment programme, including admitting patients, developing and executing the daily medical plan, participating in daily rounds, performing procedures and quickly responding to emergencies. Critical care nurse practitioners can provide continuity of care in a field where the learners (and physicians) rotate through. As a steady and anchored ICU presence who knows the workings of the relevant hospital services, the NP helps to coordinate patient care, and facilitates

communications among the rest of the interdisciplinary team. Updating and educating families and furthering discussions regarding goals of care and end of life can be time-consuming services that the unaided intensivist may need help to provide.

An example: personal experience

This paper is written jointly to describe our shared experience with the integration of a nurse practitioner into the critical care team as one constructive and cost-effective approach to address the evolving challenges of our discipline.

Alicia Dykstra (AD) was hired as a nurse practitioner in 2010 for the medical critical care team at Regions Hospital in St. Paul, MN. At that time there was little definition to the role, and over the following 7 years it has morphed and changed based on current needs. Our hospital, a blended community hospital and referral centre, is academically affiliated with the University of Minnesota and is widely recognised regionally for its acute care services in emergency medicine and across the spectrum of intensive care (general medical, cardiac, burn, trauma, surgical, neuro, etc.). Due to scheduling constraints and fluctuations in patient volumes, there are not always enough residents to fully staff both of the critical care teams dedicated to the medical ICU. During those periods, AD takes direct patient loads, developing and implementing medical plans. At other times she serves as a relief valve when the acuity and census rise, to ensure the workloads are manageable. On days when the house staff to critical care census ratio is adequate, AD works alongside the intensivist to direct management and ensure patients are receiving comprehensive care. Regardless of such modifications of assignment, on a day-to-day basis, AD participates in daily rounds, supervises or directly performs procedures, provides education for house staff and nurses, is involved in quality improvement, and sits on a number of committees. From the intensivist's perspective, the stress of periodic task overload has been substantially reduced, flexibility for educational efforts restored, and with these effects, job satisfaction raised. Finally, perhaps the most important roles have been to provide continuity from week to week among caregivers for each patient's care, to offer compassionate support to families, to offload the stress of periodically excessive caregiving demands on the intensivist, and to ensure comprehensive communication with and support of other members of the interdisciplinary team.

"PERHAPS THE GREATEST BENEFIT THAT A NURSE PRACTITIONER CAN LEND WITHIN AN ICU SETTING IS ENSURING CONTINUITY OF CARE"

Benefits

Perhaps the greatest benefit that a nurse practitioner can lend within an ICU setting is ensuring continuity of care. The NP can be a consistent presence as the intensivists and house staff rotate through the unit, establishing and nurturing a positive culture of communication and focus on safety. As patient stays become protracted this consistent presence helps ensure more seamless patient care and communication from week to week. Consequential nuances and details that may otherwise get missed can be carried forward. NPs are more likely than residents to discuss recurrently patient management throughout the day with the ICU nurses at the bedside, to interact with patients' families, and spend more time in research and administrative activities (Angus et al. 2000). When compared to pulmonary and critical care fellows, NPs characteristically spend more time in activities related to coordination of care and more time interacting with nursing, medical staff, patients and family members (Hoffman et al 2003). Satisfaction in the ICU is directly linked to patient and family-centred decision-making, communication, respect and compassion.

Given the always busy and occasionally frenetic pace of today's ICU, the physician rarely has enough time to spend with a patient and their family. Loved ones sense that their time with the physicians is fleeting and often hang on every word for fear of missing out. The disparate needs of families to stay informed and of physicians to tend urgently to more pressing matters offer fertile ground upon which a nurse practitioner can be well utilised. Nurse practitioners have had training from a nursing model of care, which uniquely positions the NP within the ICU setting. Nurses are primed to establish an alliance with a patient and family that allows for attentive listening, compassion and connection. Additionally, being available to provide frequent updates, assist with advanced care planning and have further conversations about goals of care is valued by families in the rapidly changing critical care environment.

One of the benchmarks of quality critical care is the prevention of complications and hospital-acquired adverse events as well as compliance with clinical practice guidelines. A critical care nurse practitioner can ensure adherence to core measures of quality and evidence-based practices. There are many ICU-specific safety and quality metrics and protocols for which the nurse practitioner can assist in educating rotating team members. For example, NPs are able to ensure increased compliance with deep vein thrombosis (DVT) prophylaxis, stress ulcer prophylaxis, and anaemia clinical practice guidelines (Gracias et al. 2008), as well as efforts to decrease the incidence of ventilator-associated pneumonia (VAP), decrease intubation time, and decrease the use of arterial blood gas (ABG) measurements for ICU patients (Gawlinski et al. 2001). Many of the potential complications of ICU care are preventable, and nurse practitioners are able to devote attention to these indices, leading to shorter ICU length of stay, lower rates of urinary tract infections and skin breakdown and shorter time to mobilisation and discontinuation of Foley catheter, in addition to shortened hospital course (Russell et al. 2002).

Lastly, there has been a steep increase in healthcare costs with higher volumes and an ageing population, which necessitates more cost-effective and innovative management. We cannot sustain the present growth of economic burdens with a physician-only decision maker model. As nurse practitioner salaries are considerably lower than an intensivist they could help fill the gap in the critical care workforce cost-effectively.

Supported utilisation

Published research supports the use of nurse practitioners with no perceptible differences in quality as compared to intensivist and/or fellows providing the same services. Two recent retrospective studies demonstrated that care of patients by NPs or physician assistants (PAs) is a safe adjunct to the ICU team (Costa et al. 2014; Gershengorn et al. 2011). A large prospective cohort study looked at 90-day survival for patients cared for by a NP as opposed to resident teams and found no difference; in fact, the patients cared for by a nurse practitioner were less likely to die in the ICU and had shorter hospital length of stay (Landsperger et al. 2016).

"THE ADDITION OF NURSE PRACTITIONERS IS MEANT TO BOLSTER THE CURRENT INTERDISCIPLINARY TEAM"

Mindful collaboration

The addition of nurse practitioners is meant to bolster the current interdisciplinary team so as to fulfil genuine and unmet needs, not to usurp or compete with the role of an intensivist. Key areas where a nurse practitioner might be of particular benefit include providing continuity of care, quality assurance and increased sense of patient and family connection with providers. The primary guide to implementing a highly functioning nurse practitioner is to assess the local environment for opportunities to improve and then to ensure that the NP's role provides care complementary to that of the intensivist. A nurse practitioner integrated into the critical care team can help fulfil the potential of our joint professional commitment and mission. ■

Conflict of interest

Alicia C. Dykstra declares that she has no conflict of interest. John J. Marini declares that he has no conflict of interest.

Abbreviations

ICU intensive care unit

NP nurse practitioner

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Supply purchasing for intensive care centres

A purchasing portfolio for more effective and efficient (medical) supply purchasing

This design study aims to develop a purchasing portfolio for a university hospital intensive care centre that enables the user to make strategic decisions about how to allocate scarce resources wisely across different purchase categories.

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There is a growing interest in the way hospitals purchase their (medical) products because of increasing health system costs (Van Raaij 2016). The cost of medical supplies is the second largest part of hospital budgets, after labour costs. By purchasing more strategically, it is not only possible to decrease spending, but also to increase the quality of products and the satisfaction of the staff (Lichtenberger et al. 2010). The University Medical Center Utrecht (UMCU) wants to increase its operational effectiveness (UMC Utrecht 2012) using multiple approaches, including more strategic purchasing (UMC Utrecht 2013).

The aim of this design study is to develop a relevant, scientifically grounded tool, which enables the Intensive Care Center (ICC) of the UMCU to identify explicit purchasing strategies for their purchase categories by using a purchasing portfolio. The industrial sector often uses Kraljic's (1983) purchasing portfolio as a foundation for decisions about strategic purchasing. The methodological guidelines of Van Aken and Andriessen (2011) form the foundation of this design study. Firstly, a review of the purchasing portfolio literature was performed to develop a theoretical framework. Next, semi-structured interviews with six experts were executed on two separate occasions; first, to diagnose the current situation, and later again to evaluate the tool that was designed as well as the results of a simulation of the tool. All experts work for the purchasing department of the hospital or have a management role in the ICC.

Purchasing accounts for approximately 30% of the total budget of a hospital and includes many different purchase categories, including advanced medical supplies but also office supplies (Lichtenberger et al. 2010). Professional purchasing can reduce the costs of products and/or improve the quality of products (Schotanus and Telgen 2007; Lichtenberg et al. 2010; Miocevic 2011). Professional purchasing helps organisations to achieve their goals and improve their financial sustainability.

Purchasing portfolio model

Purchasing portfolio models acknowledge that not all purchase categories should be managed in the same way (Gelderman and Van Weele 2002). A purchasing portfolio model provides insight into which strategies can be used for which goods and services. It helps to make strategic choices (Gelderman and Van Weele 2002; Olsen and Ellram 1997), improve the profitability and achieve long-term goals of the organisation (Coate 1983). The essence of a portfolio model is that there is a limited amount of resources (Coate 1983; Olsen and Ellram 1997). The use of a purchasing portfolio model leads to a differential approach in the balanced use of scarce resources (time, effort) for purchasing activities (Gelderman 2000).

In 1983 Kraljic introduced his purchasing portfolio model, leading to better insight into and management of supply risk and purchasing power. Power and dependence are very important in Kraljic's model (Caniëls and Gelderman 2007). The dependence of the purchasing organisation on a supplier is a power source for the supplier and vice versa (Caniëls and Gelderman 2005), resulting in an asymmetrical (power) relationship between buyer and supplier. The model was developed for manufacturing companies, but can easily be modified for service, government and nonprofit organisations (Olsen and Ellram 1997). The goal of our study was to find out which modifications of the Kraljic portfolio were needed to apply this model in the context of an intensive care centre. Developing a portfolio model starts with identifying factors that influence which strategy is most effective in which situation. Analysis and classification of the different factors is necessary (Fiocca 1982) to gain insight into the complexity and importance of these factors. Doing this in a team with different experts creates a shared vision on factors, strategies and purchasing effectiveness (Lichtenberger et al. 2010).

"HARD TO DIFFERENTIATE BETWEEN SUPPLIERS OF STRATEGIC PRODUCTS AND SUPPLIERS OF STANDARD PRODUCTS"

The first step in this design study was to analyse the current situation through observations and expert interviews. Over the years, the purchasing department of UMCU has increased its influence over the purchasing process, which has led to a better structured purchasing process (PP), resulting in more favourable purchasing conditions. In the past, purchasing was done by managers without specific purchasing training. A major step in the purchasing process is defining product specifications. This is done in a cross-functional (XF) team. Common factors for product specification include safety, quality, total costs, order volume, innovation, ease of use, switch possibilities and societal implications. Safety is an important factor for all respondents. The purchasing department ultimately buys the product.

More and more basic products are standardised across the hospital to capitalise on purchasing volume and achieve lower total costs. Standardisation leads to a more efficient PP where the ICC delegates the PP to the purchasing department.

The management of the ICC can then focus on more important purchases. Suppliers try to influence the PP by contacting ICC managers directly by email, telephone and/or unannounced visits. Managers waste time on suppliers that sell standardised products. To stay innovative it is necessary to have contact with suppliers that have new products, but it is hard to differentiate between suppliers of strategic products and suppliers of standard products. Innovation is especially important for the ICC, because the patient population is very complex. This population demands special products that directly affect the quality of care for a specific patient or group of patients. To buy these complex products, expertise from the XF team is needed. Important factors for specifying these products are innovation, quality and switch possibilities. To make the right decision the XF team needs to have an intense relationship with the supplier resulting in long-term contracts, earlier available innovations and sometimes developing products together. Usually, this applies to just a few (strategic) suppliers and products. The supplier and the ICC share the objective to reach long-term goals. Besides supplier relationships, market strategy is a key factor determining what the most effective PP is. The market strategy depends on the number of suppliers that are able to deliver a product(group) resulting in a more efficient PP by obtaining some products as part of a bundle. To create power over the supplier it is vital to establish a large purchasing volume. Supplier relations and market strategies have a large impact on what type of PP is chosen for which purchase categories.

Purchase categories

In the second step of this study, insights from our review of the literature were combined with our analysis of the current situation to develop a classification of purchase categories. We created a decision tree, and by answering each of the four questions at every level with yes or no, products can be placed in a product class, as presented in **Figure 1**. Common factors have a major influence on the process of creating a purchasing portfolio. Based on these specifications, five product classes have been identified, all with their own specifications, strategies and consequences. Examples of products in each class are also provided in **Figure 1**.

General products

First of all, the ICC stocks and consumes general products not used in the care process. This product class asks for an efficient PP where product standardisation is optimised (Gelderman and Van Weele 2002; Olsen and Ellram 1997). The complete process has been delegated to the UMCU resulting in no effort from the ICC, lower prices and better purchasing contracts. ICC managers should not spend time on managing supplier relationships for these products.

General healthcare products

The second product class contains general healthcare products, which is split into subclasses 2a and 2b. Standardisation across the hospital is again important to increase purchasing volume (Gelderman and Van Weele 2002) and hence make these products easier to manage. The purchasing department uses the total volume to increase power over the supplier. It is in the interest of the ICC to standardise as many products as possible to achieve a significant decrease of the total costs (Olsen and Ellram 1997). These products are characterised by low switching costs. Only when the total costs of a product account for a significant part of the budget or when the product is important for the care process, will the ICC take part in the XF purchasing team resulting in some influence on the decisions. This distinguishes product classes 2a and 2b, with class 2a fully delegated to the purchasing department, and the ICC participating in the first phases of the PP for class 2b. Also for product class 2, ICC management should not spend precious time on managing supplier relationships.

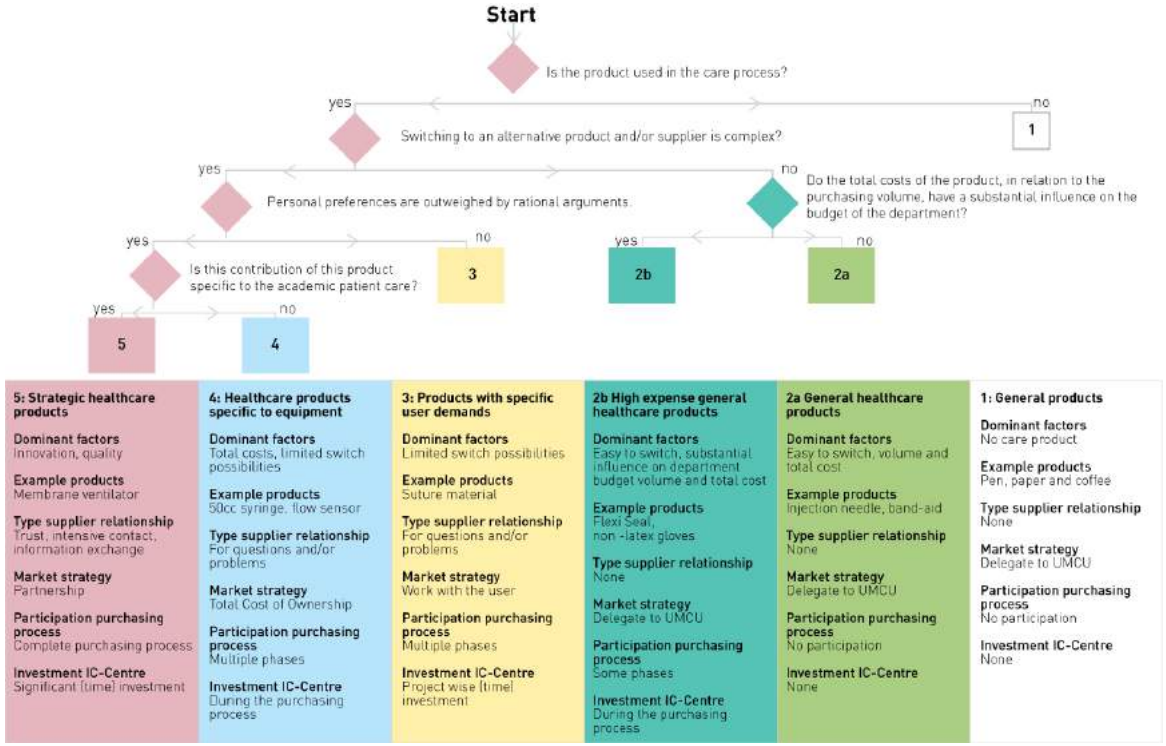

Figure 1. Portfolio Model for the ICC

Products with specific user demands

Class 3 consists of products with specific user demands. This makes switching products and/or suppliers more difficult. The ICC needs to work with the user and the purchasing department to see if it is possible to switch to class 2 products resulting in lower total costs (Gelderman and Van Weele 2002). Class 3 products are generally hard to manage and require time and effort from ICC management to discuss standardisation potential with internal users (Olsen and Ellram 1997).

Care-related products (consumables)

Class 4 consists of care-related products (consumables) specific to equipment. It is vital to use the Total Cost of Ownership concept to make well-founded choices about equipment in combination with consumables. Most equipment is used for many years, and switching consumables is difficult or even impossible during the operational lifetime of the equipment. Significant time investment is necessary from ICC management, but only during the PP of the equipment. Furthermore, a regular review of consumables can be used to identify alternatives for consumables during the operational lifetime of the equipment.

Strategic healthcare products

Finally, class 5 consists of strategic healthcare products used for the specific patient population of an academic hospital. Care for these high-demand patients results in new scientific knowledge and innovative products can directly influence chances of survival. This makes this ICC different from an ICC in a non-academic hospital. In this product class the focus is on developing products for care together with the supplier. There is a long-term commitment, and creating a partnership with the supplier is essential (Olsen and Ellram 1997), with investments from both sides (Gadde and Snehota 2000). The ICC needs to be part of the complete PP to build the required buyer-supplier relationship and influence decisions.

ICC product portfolio

We reviewed the current product portfolio of the ICC and classified them according to our decision tree. This simulation of our portfolio model showed (see **Figure 2**) that 75% of all products in stock at the ICC (classes 1 and 2a), can be managed by fully delegating the PP to the purchasing department. Many suppliers from these two product classes still demand an intense supplier relationship with the ICC, according to the interviewees. This consumes time from ICC managers that is not spent wisely. Significant time investment is needed in the first phases of the PP for class 2b to keep control over a large part of the total costs. However, these 58 products need to be purchased centrally by the UMCU to benefit from larger volumes. A total of 21 products (class 3) need more attention to discuss with internal users if switching is possible to be able to decrease the cost. A rather large number of products (41 products) belong to product class 4, representing consumables for which the ICC is locked in to specific suppliers. For these products, ICC management needs to invest time whenever new equipment is being considered. Only 8 products (class 5) require an intense supplier relationship to benefit the specific population of the ICC. In this product class, product volumes and costs for the organisation appear lower due to research funding– giving the supplier relationship an extra dimension. The interviewees confirmed that the purchasing portfolio and the results from the simulation showed various possibilities to improve the purchasing process for the ICC.

	Number articles in stock of the ICC	Percentage of the total costs
Class 1	103	2.75%
Class 2a	306	16.11%
Class 2B	58	46.23%
Class 3	21	9.09%
Class 4	41	18.90%
Class 5	8	6.93%
	537	100%

Figure 2. Results of the Simulation

Conclusion

The purchasing portfolio enables the ICC to easily classify a product and make conscious and strategic decisions about the allocation of scarce resources, such as time spent with suppliers. The portfolio can be applied at similar departments in (university) hospitals. Knowledge of purchasing portfolios like this one enables ICC managers to have meaningful discussions with purchasing professionals. ■

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Abbreviations

ICC intensive care centre

PP purchasing process

XF cross-functional

Reference

For full references, please email editorial@icu-management.org or visit https://iii.hm/far

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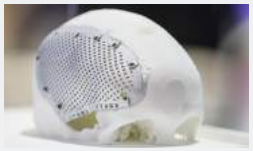

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Reducing avoidable harm and death from sepsis and acute kidney injury

Achieving large-scale behaviour change with the NHS Wales programme

In 2016 NHS Wales received the Global Sepsis Award, recognising the work throughout the healthcare system on improving identification and treatment of sepsis, which has coincided with an apparent reduction in mortality and ICU admissions for patients with two International Statistical Classification of Diseases and Related Health Problems (ICD-10) sepsis codes. The main vehicle for change has been participation of all Welsh healthcare organisations in the 1000 Lives Rapid Response to Acute Illness Learning Set (RRAILS). This article examines some of the factors which have been critical in achieving large-scale behaviour change as part of this patient safety programme.

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Acute deterioration in Wales

The National Health Service (NHS) in Wales is a devolved healthcare system serving a population of 3.1 million via sixteen acute and tertiary hospitals supported by numerous community hospitals and a single Welsh Ambulance Service.

Sepsis and acute kidney injury (AKI) have been appreciated by Welsh Government and NHS Wales as major causes of avoidable harm and death for many years and were the subjects of patient safety alerts in 2014 and 2016 respectively. The treatment of sepsis became a 'Tier 1' priority for NHS Wales in 2013.

Measuring the incidence and burden of sepsis is difficult due to issues of definition and data capture. Scaling the findings of a large meta-analysis (Fleischmann et al. 2016) for the population of Wales gives an incidence of between 8000-13,000 per annum with an associated mortality of between 2200-2300.

These estimates accord both with extrapolation from an inspection of UK critical data (Daniels 2011a) and a retrospective review of mortality within one Welsh hospital (Robinson 2013). The latter study estimated sepsis to be responsible for approximately 15% of hospital deaths.

The 'Size of sepsis in Wales study' (Szakmany et al. 2016) found a prevalence of sepsis and severe sepsis in Welsh acute hospitals of 5.5% with associated mortality at 90 days of 31%.

Although AKI is acknowledged to be a common feature of sepsis the extent of co-existence is unclear. However, a comprehensive system of AKI electronic alerts introduced in 2015 has enabled the quantification of AKI in Welsh hospitals. The incidence reported from the alert system is greater than 4000 patients each month whilst analysis has found an associated mortality of 25.6% (Holmes et al. 2016).

Changing behaviour at scale

The main vehicle for improvement for acute deterioration in NHS Wales has been the active participation of all Health Boards and Trusts in the 1000 Lives Improvement Service Rapid Response to Acute Illness Learning Set (RRAILS). RRAILS was launched in 2011 with the purpose of introducing the National Early Warning Score (NEWS), sepsis screening and implementation of the Sepsis 6 care bundle.

In 2016 NHS Wales received the Global Sepsis Award from the Global Sepsis Alliance with a citation from Professor Dr. Konrad Reinhart and Dr. Carl Flatley that reads:

> *Your tremendous efforts in our common fight against sepsis are a shining example and an inspiration for other sepsis initiatives around the world showing what can be done with outstanding commitment and great passion.*

We believe that there are several distinct features of the RRAILS programme in NHS Wales that have enabled achievement of this success, which are discussed below.

Focus on reliability—right treatment, every patient, every time

The landmark study by McGlynn et al. (2003) demonstrated that what they referred to as the "defect rate in technical quality of American healthcare" stood at 45%, whilst a UK study (Burnett et al. 2012) found reliability rates in simple healthcare procedures at 82-87%. The implications of these findings are that healthcare systems are poor at achieving consistency in delivery of the basic elements of healthcare and that this level of reliability would be unacceptable in many industries and certainly in those where safety is critical.

The report *Time to Intervene?* (National Confidential Enquiry into Patient Outcome and Death [NCEPOD] 2012) demonstrated that the consequences of this poor process reliability in the recognition, escalation and response to acute deterioration resulted in a high rate of avoidable mortality.

The originators of the concept of Safety II argue that "Safety management should .... move from ensuring that 'as

few things as possible go wrong' to ensuring that 'as many things as possible go right'" (Hollnagel et al. 2015). The focus of the RRAILS programme has therefore been on making things go right as often as possible and upon improving the rate of 'always events' rather than reducing 'never events'.

To achieve this we have supported clinicians with standardised tools and operating procedures, used human factors principles to encourage implementation and enabled clinical teams to measure their own improvement.

NEWS – a common language of risk

The National Early Warning Score (NEWS) has been advocated by the Royal College of Physicians for adoption in all UK hospitals following evaluation as the early warning score that was the best predictor of death within 24 hours (Prytherch et al. 2010). NEWS was fully implemented in all acute Welsh hospitals by 2013 (the first country to achieve this).

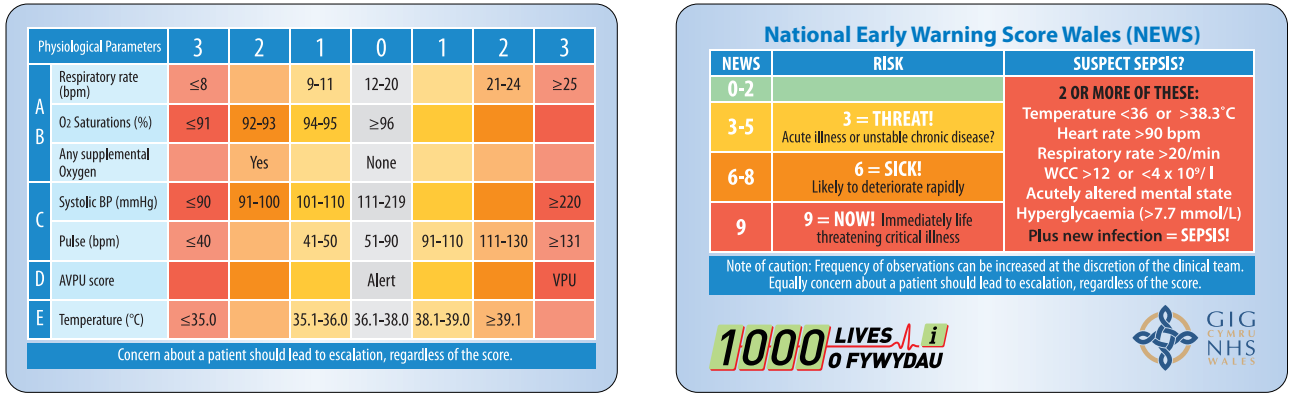
Implementation has enabled the common setting of triggers of 3, 6 and 9 as representative of low, medium and high risk and has enabled stratification of escalation response. However, its primary value has not been that of being a perfect tool—it is not—but rather in its provision of a common language through which clinicians in different geographical and care settings can communicate.

"THE STANDARD OPERATING PROCEDURE SHOULD ACT AS A SAFETY NET TO PREVENT ERRORS OF OMISSION"

Consequently NEWS has been adopted by the Welsh Ambulance Service, most community hospitals and primary care teams and even in some private care homes.

'Good enough' tools enable the whole team

The universal adoption of NEWS meant that a common screening tool could be developed. As of 2012 NHS Wales started to use a standard set of criteria based upon a NEWS of 3 or more plus two or more Systemic Inflammatory Response Syndrome (SIRS) criteria and the suspicion of infection.



Physiological Parameters		3	2	1	0	1	2	3
A B	Respiratory rate (bpm)	≤8		9-11	12-20		21-24	≥25
	O2 Saturations (%)	≤91	92-93	94-95	≥96			
	Any supplemental Oxygen		Yes		None			
C	Systolic BP (mmHg)	≤90	91-100	101-110	111-219			≥220
	Pulse (bpm)	≤40		41-50	51-90	91-110	111-130	≥131
D	AVPU score				Alert			VPU
E	Temperature (°C)	≤35.0		35.1-36.0	36.1-38.0	38.1-39.0	≥39.1	

Concern about a patient should lead to escalation, regardless of the score.

Figure 1. National Early Warning Score (NEWS) card

Stage 1: identification mainly falls to the healthcare support workers (HCSW) who perform vital signs observations. The screening tool information has been codified on plastic credit card-sized NEWS cards carried by many staff **(Figure 1)** and on the observation charts, and so serves to encourage the HCSWs to act quickly to start the escalation process.

Stage 2: diagnosis and decision to treat is strongly aided by the use of NEWS which, recent evidence indicates, is a better predictor of sepsis than other tools used outside of critical care (Churpek et al. 2017). We are now able to make a strong recommendation to treat for sepsis at NEWS of 6 or more in the presence of infection, based of course on clinical judgement.

Always events not never events

One of the notable findings of the report Just Say Sepsis (NCEPOD 2015) was that of improved process and outcome measures where the Sepsis 6 care bundle was used to treat sepsis. Daniels et al. (2011b) found a significant reduction in mortality associated with reliable implementation of the bundle.

The Sepsis 6 care bundle has been adopted as the standard throughout Wales with the documentation in most cases simply consisting of carbon copy forms. Whilst the evidence for most elements of the bundle is now less strong, it has become apparent that its use has an extra ability to drive and motivate completion of sepsis treatment within one hour.

A similar approach has been taken with response to the AKI e-alerts with a four-item care bundle. Preliminary results from a trial involving the Critical Care Outreach Team (CCOT) in instigating the bundle have been promising.

Make it easy and attractive to 'do the right thing'

The Behavioural Insights Team (BIT), famous for their development of 'nudge' theory, uses the acronym EAST (Easy, Attractive, Social

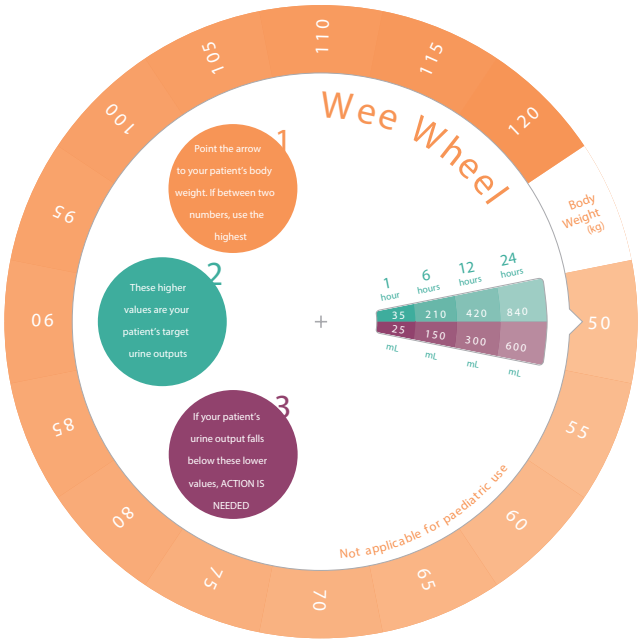


Figure 2: Wee Wheel

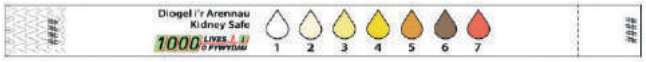


Figure 3: Kidney Safe Bracelet

and Timely) to describe an approach to achieve behaviour change (Service 2014). The authors argue that in order to encourage a behaviour it is necessary to make it easy and attractive to adopt that new behaviour. This has particular relevance in healthcare systems where behaviour change may have been traditionally attempted by 'top-down' diktats and punitive performance management.

An important part of the EAST model is the idea of setting the default action. This can be seen to be integral to the standardised recognition, escalation and treatment tools for AKI and sepsis. It is important to emphasise that setting the default should not force clinicians to act against their better judgement, but instead the standard operating procedure should act as a safety net to prevent errors of omission. Thus the dynamic changes from one of opting in to one where deviance from the default should be justified.

Give permission to act

In innovating to achieve behaviour change it is also possible and we believe vital that clinicians are given 'permission to act'. The RRAILS team has collaborated in the design of several physical tools that fulfil this function including the NEWS Card (**Figure 1**), Wee Wheel **(Figure 2**) and KidneySafe Bracelet (**Figure 3**), which are popular, easy to use and encourage the prevention of AKI and sepsis (Subbe 2015).

An important development has been that of the sepsis bag, box or trolley which has been developed and tested by several of the participating Health Boards.

The idea of this innovation is simple and expresses very much the human factors principle of co-locating all the elements needed to complete a procedure, in this case the Sepsis 6, in order to make it far more likely that the procedure will be carried out correctly.

Plot the dots – the importance of measurement

A phrase attributed to the quality improvement expert W.E. Deming is "Without data you're just another person with an opinion."

With this in mind, a vital part of the RRAILS programme has therefore been to support frontline clinicians to understand their performance by giving them tools to enable them to develop quick and easy run charts of incidence and compliance with sepsis treatment for display in ward areas.

There has been an intentional move to promote the use of run charts as the means of recording data and, where possible, to record data on an 'every patient' rather than sampled basis. The run charts are annotated to enable the teams to appreciate the effect of changes in practice. The run chart establishes a shared narrative and so promotes the feeling of 'shared mission' amongst the team.

The literature on so-called high reliability organisations (Weick and Sutcliffe 2007) details how 'sensitivity to operations' or the ability to understand at the highest organisational levels how the core work is progressing is essential. The reporting on the incidence of positive sepsis screening and compliance with Sepsis 6 has fulfilled this criteria to some extent and these measures form part of many organisations' metrics frameworks.

Programme evaluation

At a national level we were able to look at the incidence of sepsis recorded in hospital stays and subsequent mortality (in and out of hospital), by linking hospital episode data with death certificates.

Hospital stays were selected by looking for episodes with an ICD-10 diagnostic code for 'streptococcal sepsis' (A40) or 'other sepsis' (A41) (**Figure 4**). We have also looked at coding for urosepsis and pneumonia to assure ourselves that incidence or mortality was not simply being coded differently over time, and conferred with clinical coding colleagues in the national informatics service about possible changes in coding practice (for example, the change from 'septicaemia' to 'sepsis' in the 4th edition of ICD-10).

A straightforward inspection of the data reveals a reliable increase in recorded incidence over the last decade. By contrast, the annual number of deaths within 30 days of discharge fell for several years in a row from 2011 onwards and remains lower than 6 years ago.

Meaningful statistical analysis of the mortality rate is complicated by the combination of both likely improved recognition and diagnosis, and possibly genuine increases in incidence. The rate clearly drops enormously, but this is largely due to the increase in recorded incidence. Provider-level data shows more complicated patterns of changing incidence, mortality and critical care admission.

Nevertheless we believe that the observed reduction in the crude number of deaths against this backdrop of increasing incidence, and in the context of compelling local data, strongly suggests that hundreds of deaths may have been avoided since the introduction of the programme. Similarly the national data also suggest that critical care admissions of those with sepsis fell slightly after 2012. Given the expected lengths of stay for those with sepsis, this may represent a significant potential saving.

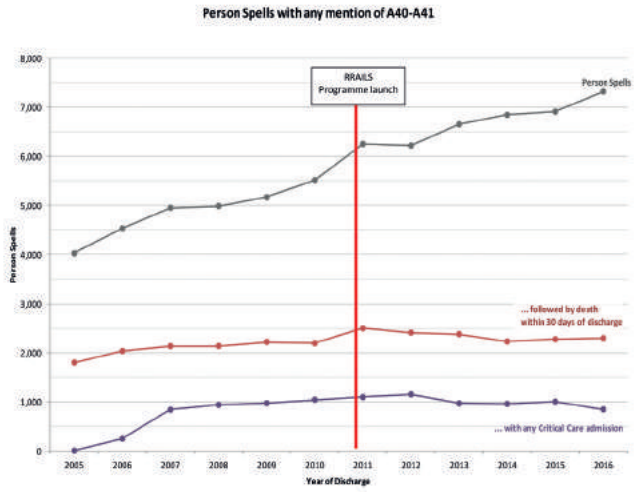


Figure 4: Person spells with any mention of A40-A41

Conclusion

Correlation does not prove causality and we must be cautious about the attribution of improved outcomes to behaviours that have taken place across many different organisations in differing care settings over lengthy timescales.

Nevertheless it seems reasonable to claim that patient safety programmes situated in healthcare economies serving populations of between three and five million and focusing upon standardisation to achieve process reliability, enablement of all clinicians to act, quick and easy measurement and creation of a social movement can be an effective model for improvement. ■

Conflict of interest

Chris Hancock declares that he has no conflict of interest. Adam Watkins declares that he has no conflict of interest.

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- Cwm Taf University Health Board
- Hywel Dda University Health Board
- Powys Teaching Health Board
- Public Health Wales
- Velindre NHS Trust
- Welsh Ambulance Services NHS Trust

Abbreviations

AKI acute kidney injury

NEWS National Early Warning Score

RRAILS Rapid Response to Acute Illness Learning Set

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Implementation of early and structured rehabilitation in ICU

The importance of multidisciplinary team working and communication

Early mobility has been shown to be both safe and feasible within critical care populations. When introduced, early mobilisation programmes are associated with an improvement in short-term outcomes and long-term recovery in critical care patients. Despite this, point prevalence surveys have shown rehabilitation levels remain low, and as such an increased focus has been placed on barriers to implementation. This article explores lessons learned from previous studies in this area to help guide clinicians in successful implementation, including key considerations for team working and key components in rehabilitation practice structure.

Patients admitted to ICU often experience significant weakness, with muscle loss found to be as high as 20% within the first seven days for those in multi-organ failure (Puthacheary et al. 2013). The causes of this high rate of muscle loss are multifactorial, including factors such as sarcopenia from premorbid conditions, sepsis and prolonged immobility. When present, ICU-acquired weakness is associated with prolonged weaning from mechanical ventilation, longer ICU and hospital stays and increased mortality levels, as well as severe functional impairments and reduced pace and degree of recovery in ICU survivors (Griffiths and Hall 2010).

The evidence to support rehabilitation within critical care is growing, demonstrating rehabilitation to be both safe and feasible for critical care populations (Bailey et al. 2007; Umei et al. 2016). Early and structured rehabilitation has been proven effective in improving short-term outcomes and long-term recovery in critical care patients. Specifically, early and structured rehabilitation programmes have been shown to decrease both ICU and hospital length of stay (LOS) (Morris et al. 2016; Needham et al. 2010; McWilliams et al. 2015), reduce the incidence and duration of delirium, as well as improve functional ability at critical care and hospital discharge (Schweikert et al. 2009).

Despite the growing evidence base for early rehabilitation, a number of recent point prevalence surveys have demonstrated levels of rehabilitation within critical care to be low, particularly whilst patients are receiving mechanical ventilation. A 3-day point prevalence survey of 38 ICUs in Australia and New Zealand found no patients requiring mechanical ventilation sitting out of bed or walking on the days in question (Berney et al. 2013). This was also the case in a similar study to assess mobility levels in German ICUs, which found only 4% of patients in ICU standing or walking (Nydahl et al. 2014). Additionally, more recent studies looking at increased dosage or frequency of physiotherapy have failed to recreate the positive results previously seen (Denehy et al. 2103; Moss et al. 2016).

Barriers to implementation

The cause of this lack of translation into practice has become a source of much interest, with findings suggesting the causes are multifactorial and vary between nations, regions or even ICUs within the same hospital. Recent research has therefore explored the specific barriers to implementation of early mobility programmes in ICU, finding that whilst barriers were multifactorial, important common themes were identified. Key themes included patient factors (i.e. instability and safety of mobilisation), clinician-related factors (knowledge of why and how to commence early rehabilitation), environmental influences (i.e. competing priorities and staff availability) and unit culture and environment (Costa et al. 2017; Parry et al. 2016). Taking a deeper look at the evidence for early rehabilitation could provide some important answers for clinicians looking to implement similar interventions, with the need to promote open lines of communication and work towards achieving multidisciplinary culture change essential to improve outcomes (Sibilla et al. 2017).

A number of studies for early rehabilitation have used the quality improvement approach, which encompasses a variety of methods involving a team of individuals working towards a common goal or aim (U.S. Department of Health and Human Services Health Resources and Services Administration 2011). The key first stage to any quality improvement process emphasises the need to engage with key stakeholders to identify barriers and solutions for the project goals (Pronovost et al. 2008). As we have learned, the concept of implementing early mobilisation programmes is not a 'one size fits all' approach and the specific barriers to implementation may be unique to each individual ICU. Underpinning this engagement process was a focus on the importance of collaborative team working, ensuring everyone had a voice and was involved in the change process. This often involves the creation of team leaders and champions for rehabilitation practice from different healthcare professions. These champions are tasked with overseeing implementation, both within their own individual professions as well as within the wider multidisciplinary team, a process which

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ensures ongoing consistency with proposed service changes and which is crucial for team effectiveness. Team leaders play a key role in facilitating the development of shared objectives, overseeing decision making processes and guiding the team to reach their synergistic potential, whereby the collective effort surpasses the sum of individual contributions (Kozlowski et al. 2006).

"RECENT POINT PREVALENCE SURVEYS HAVE DEMONSTRATED LEVELS OF REHABILITATION WITHIN CRITICAL CARE TO BE LOW"

Overcoming barriers - safety

A number of perceived barriers to early mobilisation in the ICU are either directly or indirectly related to the safety of such activities, questioning the risks and potential for harm in mobilising patients who by their very nature are critically ill (Holdsworth et al. 2015). The argument against this is strong, with numerous studies exploring the safety of progressive mobility within ICU populations and more recently an expert consensus paper published by leading experts in the field on this very topic (Hodgson et al. 2014). This paper was supported by numerous studies assessing safety of mobilisation programmes within critical care, suggesting a low incidence of adverse events and helping to guide clinicians' decision making with when and how to proceed with early rehabilitation. In evaluations of current practice however, a number of perceived safety limitations to early mobilisation still exist with apparent ongoing concerns regarding the appropriateness of such interventions for patients with ongoing organ failure (McWilliams et al. 2016).

One potential solution, which may be suitable to help decision making and guide practice, is through the use of early mobility protocols. There is strong evidence to support the use of protocols for other areas of care such as sedation minimisation and ventilator weaning (Girard et al. 2008; Kress et al. 2000; Ely et al. 1996). Expanding protocol use to include mobilisation seems possible, and excellent examples exist to help guide development (McWilliams et al. 2015; Engel et al. 2015; Pandharipande et al. 2010). The use of protocols for mobilisation may have a number of beneficial effects, helping to guide initiation and identify patients who are deemed sufficiently haemodynamically stable and ready to start more active mobilisation. Commencing mobilisation is however only the start of the rehabilitation journey and any protocol developed should also provide a structure or framework to empower healthcare professionals to progress activity and ensure ongoing collaboration between team members.

Overcoming barriers – structure and culture

A recent survey of current practice, including 951 ICUs from 4 countries, demonstrated significant international variation in the delivery of rehabilitation within critical care (Bakhru et al. 2016). Importantly however, the survey did provide useful insights into key components required to support early mobility programmes. The presence of a dedicated physiotherapist, multidisciplinary (MDT) team ward rounds and daily goal setting for rehabilitation were significantly associated with the presence of established early mobility practice within the ICUs surveyed. Once again, establishing an open forum for MDT communication is vital to support these processes. Previous findings have shown that in the absence of specific multidisciplinary care rounds healthcare professionals often prioritise information to reflect their own clinical roles, which may in turn lead to errors in communication or missed information that could be key to a patient's care (Miller et al. 2009). In an observational single-centre study, communication events between nurses and physicians comprised only 2% of observed activities in the ICU, but were associated with 37% of errors (Donchin et al. 1995). A similar finding was observed in a multicentre study where poor teamwork contributed to 32% of patient safety incidents (Pronovost et al. 2006).

Patient care rounds are therefore an important team activity where the patient's plan of care is discussed formally and tasks prioritised. There is evidence to support the initiation of patient care rounds in other areas of care, where they have been associated with positive patient outcomes. For example, implementation of daily multidisciplinary rounds by nursing staff, a physician and a respiratory therapist to review a checklist of ventilator bundle goals for each patient decreased the incidence of ventilator-associated pneumonia (VAP) from 1.5 per month to 0.5 per month in a study of surgical trauma ICU patients (Stone et al. 2011). Conversely, failure to develop consistent treatment goals among ICU staff has been identified as a key source of intra-team conflict, which in turn is perceived to impact on outcomes such as decreased quality of patient care, staff burnout and wasted resources (Danjoux et al. 2009). Given the complex nature of early rehabilitation in patients with multi-organ failure, these rounds provide team members with the opportunity to discuss the patients' rehabilitation in the context of medical stability, any current plan for weaning of sedation and respiratory support, management of delirium and to highlight other team member tasks which may require completion (Bakhru et al. 2016).

Conclusion

The concept of implementing early mobilisation programmes is not a 'one size fits all' approach, but needs to be one of internal reflection and evaluation within multidisciplinary teams. A variety of factors needs to be considered, evaluated and then re-evaluated for

successful change to be introduced and maintained. The issue runs deeper than simply increasing the dose or duration of therapy, and clinicians need to explore the structure and culture within critical care units to ensure effective and established behavioural change. Simple strategies such as daily MDT ward rounds, team meetings, collaborative inter-professional goal setting and visible goal targets are all excellent tools to support changes in practice. The development of shared goals is crucial for fostering team commitment and a shared sense of identity which makes effective teamwork possible. This approach of team working and open communication has been replicated in a number of successful quality improvement initiatives of early mobilisation including our own, where individual centres evaluate their own barriers and generate solutions to overcome them with a consistent improvement in evaluated outcomes. ■

"CONCEPT OF IMPLEMENTING EARLY MOBILISATION PROGRAMMES IS NOT A 'ONE SIZE FITS ALL' APPROACH"

Conflict of interest

David McWilliams declares that he has no conflict of interest.

Abbreviations

ICU intensive care unit

MDT multidisciplinary team

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Improving quality of care in severe traumatic brain injury patients

Development of a process indicator-based plan-doact-check cycle in a single-centre quality improvement initiative

To assess whether intracranial pressure (ICP) management in severe traumatic brain injury patients is being applied according to our institutional protocol we developed a process indicator aimed at improving quality of care.

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Background and rationale

Traumatic brain injury (TBI) is a leading cause of morbidity and mortality throughout the world. The initial management of primary brain injury may include prompt surgical decompression of intracranial haematomas. In the hours and days following the trauma, secondary brain injury can develop as a result of a cascade of molecular injury mechanisms. This cellular injury results in altered mitochondrial functioning, cell apoptosis and oedema. Oedema raises ICP, compromising cerebral perfusion pressure (CPP) and resulting in ongoing and additional brain injury. Given the importance of halting the vicious circle of secondary brain injury resulting in worse clinical outcome, prompt ICP management and maintenance of CPP according to a strict incremental management protocol are essential. Most international guidelines state that an ICP exceeding 20 mmHg should be treated (Bratton et al. 2007). The incremental management steps involve analgesia and sedatives first, followed by osmotic therapies to reduce cerebral oedema and ultimately the so-called second-tier therapies including barbiturates or decompressive craniectomy. Implementation of these guidelines in clinical practice can have a significant impact on outcomes following TBI (Fakhry 2004; Arabi 2010), and this effect may be augmented with better adherence and more aggressive management (Bulger 2002; Cnossen 2016).

The Erasmus Medical Center is an academic (neuro) trauma centre. Our TBI protocol is based on strict ICP management according to international guidelines. As part of a departmental quality improvement strategy in 2016, we decided to assess whether this protocol was optimally applied in our ICU. For this purpose we were greatly interested in a quantitative measurement tool that would adequately reflect ICP protocol adherence, but would not be too complex to calculate or interpret. Over the last decade, numerous quality indicators have been developed as guides to monitor, evaluate and improve the quality of care. Quality indicators are measurement tools that focus on the availability of specific means (structure), the actual delivery of care (process) or the result of care (outcome).

Quantitative research usually reports outcome indicators, such as mortality or adverse events. Process indicators refer to the appropriateness of delivered care such as, in our case, protocol or guideline-recommendation adherence (Lingsma 2010). An intrinsic advantage of process measures is that they are generally more sensitive for or directly linked to changes in the quality of actual clinical care than outcome measures. Furthermore, only a valid process indicator can detect flaws in the practical management of, for instance, ICP treatment that would otherwise go unnoticed when looking at outcome measures alone. Improving the quality of care starts with the identification of such flaws and subsequently translating them into improvement measures. With the use of a process indicator for ICP treatment we aimed to identify frequent causes of non-adherence that we could subsequently address following a plan-do-check-act (PDCA) method (Taylor et al. 2014). As an additional benefit, process indicators are applicable to relatively small patient groups to provide information on the way care is actually delivered.

We therefore aimed to use ICP protocol adherence as a process indicator to reflect the quality of our ICP treatment in TBI patients. For this purpose, we performed a literature search on process indicators for ICP management to be used. However, this search yielded no applicable results, and we concluded that in the field of ICP treatment in TBI patients, a validated quality indicator such as protocol adherence had yet to be developed and evaluated.

"ONLY A VALID PROCESS INDICATOR CAN DETECT FLAWS IN THE PRACTICAL MANAGEMENT OF, FOR INSTANCE, ICP TREATMENT"

Objective

To develop and apply a simple ICP process indicator and additionally construct a plan-do-check-act (PDCA) cycle describing key learning points and further iterative steps to improve quality of care in TBI patients.

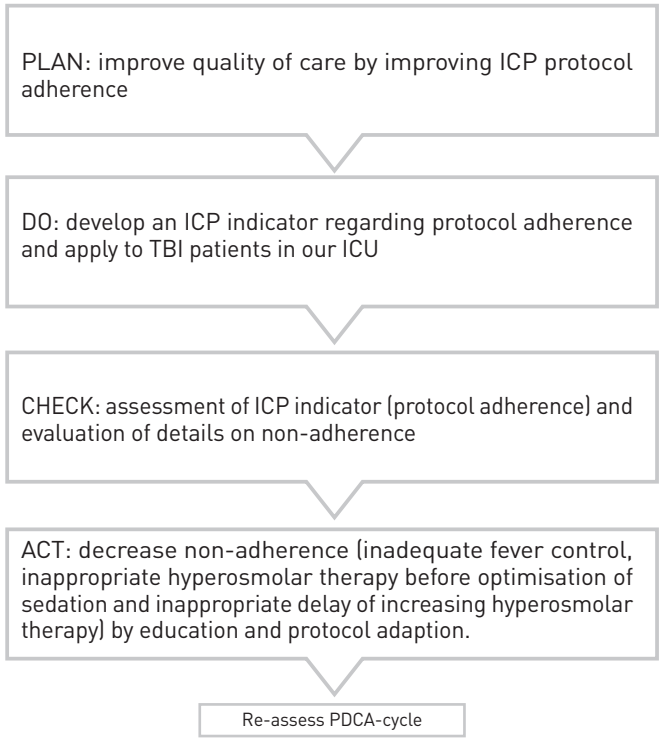

Figure 1. PDCA cycle

Methods

This single-centre quality improvement project took place on the ICU of the Erasmus Medical Center in Rotterdam, the Netherlands. Institutional review board approval was obtained. It was judged that given the observational nature of the investigation and the fact that it was a quality improvement project informed consent was not a necessity.

First, we used focus group interviews to reach consensus on a suitable ICP indicator that was face-valid. The focus group consisted of a neurointensivist, neurosurgeon, ICU nurse with special expertise in neurocritical care, research nurse, quality manager and ICU manager. The result was an ICP indicator that was defined as:

> *the number of patients with ≥ 1 period of ICP > 20 mmHg for more than 30 minutes without appropriate treatment escalation (numerator) according to the protocol, as a percentage of the total number of patients with ICP monitoring (denominator). Ideally the indicator should be zero (%).*

This indicator was then evaluated for its relevance, reliability, validity, feasibility and usability using the Appraisal of Indicators through Research and Evaluation (AIRE) 20-points checklist (Dimick, 2010). It met all the requirements of the AIRE 20-points checklist and was therefore considered to be a suitable process indicator. Finally, the ICP indicator was tested for feasibility in all the adult TBI patients receiving ICP monitoring and treatment at our ICU, admitted between April and September 2016.

As stated by our protocol, indications for ICP monitoring are defined as a Glasgow Coma Score (GCS) ≤ 8 and an abnormal CT scan showing evidence of mass effect from lesions such as haematomas, contusions or swelling, or a GCS ≤ 8 with a normal CT scan but two or more of the following items: age above 40 years, an M2 or M3 on the GCS scale or a systolic blood pressure below 90 mmHg. Exclusion criteria are patients that did receive an ICP monitoring device at ICU admission, but were considered to have a moribund prognosis (based on the interpretation of the CT scan and ICP at the start of treatment by the attending neurosurgeon and intensivist). We excluded this last category of patients from analysis, because they were not expected to represent patients in whom strict adherence to the ICP treatment protocol would confer benefit. Data on ICP levels and applied treatments were collected from our patient data management system (PDMS) that automatically records ICP levels with a ten-minute interval.

Reasons for protocol non-adherence (defined as ICP > 20 mmHg for ≥ 30 minutes but no escalation of the management) were first assessed by a research nurse and subsequently interpreted by an ICU fellow and neurointensivist. Lessons learned regarding details of non-adherence were incorporated in a predefined PDCA cycle construct. A PDCA cycle is a four-step management method for continuous improvement of processes. The fundamental principle of this method is iteration: once a hypothesis or target is obtained or not obtained, executing the cycle and repeating it will extend knowledge and will bring one closer to perfection of the process. Ultimately a process indicator and PDCA cycle well applied will ideally result in the indicator becoming redundant, since no further improvement for that specific indicator can be obtained.

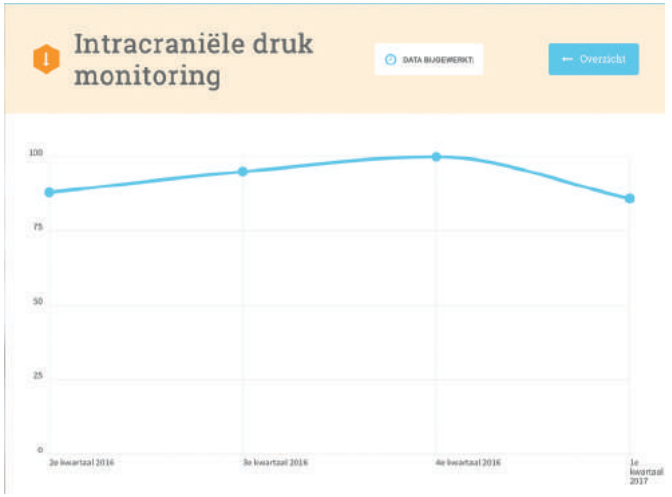

Figure 2. Snapshot from our institutional website with the ICP indicator showing guideline adherence quarterly. The fourth quarter of 2016 (third dot from the left) had the highest adherence (100%).

Table 1. ICP indicator results

Month	No. patients with ICP monitoring	No. patients with moribund diagnosis	No. patients with ICP ≥ 20 mmHg ≥ 30 mins	No. cases of protocol breach	Numerator	Denominator	Indicator (%)
April	4	0	4	1	1	4	25
May	11	0	9	1	1	11	9
June	4	2	2	0	0	2	0
July	7	1	5	0	0	6	0
August	10	1	9	1	1	9	11
September	7	1	7	0	0	6	0
Total	43	5	38	3	3	38	8

Results

We analysed 43 patients, of whom 5 had a moribund prognosis, resulting in 38 included patients (**Table 1**). Adherence to treatment protocol was inadequate in 3 cases (8%). In 1 patient, there was an adequate intervention (osmotic therapy was started according to protocol), but not within the set time, while in 2 patients the therapy was inadequate (failure to control fever resulting in several temperature spikes and the start of osmotic therapy whilst sedation was still inadequate). With these data we constructed a PDCA cycle (**Figure 1**).

The first step (**Plan**) is to establish an objective, in our case to improve quality of care by improving protocol adherence. The second step (**Do**) is to implement a measure to reach your objective. Ours was the development and implementation of the ICP indicator. After implementation, results of the ICP indicator were studied in the third step (**Check**). In the final step (**Act**), we aim to implement improvement measures based on the results of step three. In practice this meant that we aimed to provide, additional education of the complete medical and nursing staff on our ICP management protocol, and specifically provided feedback on the indicator (**Figure 2**) to the medical and nursing staff. For this purpose, we used our department's website, individual emails and newsletters and explained the potential for improvements.

Since the PDCA cycle is an iterative process, we plan to continue reporting the process indicator and thereby assess the outcome of this indicator on protocol adherence every six months after the implementation of extra education of the staff. We are currently in this process and first results of further indicator measurements are shown in **Figure 2**.

Conclusion

We showed the feasibility of our ICP process indicator, which proved to be useful for the construction of a simple PDCA cycle. Since the cycle is aimed to be iterative, either further improvement can be expected and/or development of a slightly adapted indicator may be expected depending on the user's convenience and perceived usability, since not only indicator outcome but also indicator construct will be re-evaluated.

Future perspectives

The next step will be to try and translate this process improvement into a possible outcome benefit. For example, we could compare predicted outcome (mortality) of our TBI patients (using the CRASH score developed by IMPACT **https://iii.hm/dr8**) with actual outcome as a benchmark measure, and relate this information to the level of adherence to the process indicator. One might hypothesise that the ideal indicator is sensitive to processes of care, provides clear information on how to improve and is associated with a benchmark outcome. We hope to further develop this concept in our institution and publish results on its feasibility in the future when patient numbers included allow for more robust statistical analyses. ■

Conflict of interest

Joyce A.M. Heijneman declares that she has no conflict of interest. Jasper van Bommel declares that he has no conflict of interest. Mathieu van der Jagt declares that he has no conflict of interest.

Abbreviations

CPP cerebral perfusion pressure
ICP intracranial pressure
PDCA plan-do-check-act
TBI traumatic brain injury

Reference

For full references, please email editorial@icu-management.org or visit https://iii.hm/fao

Improving sepsis outcomes in Brazil

Flávia Machado is Professor of Intensive Care and Head of the Intensive Care Section of the Anesthesiology, Pain and Intensive Care Department at the Federal University of São Paulo in São Paulo, Brazil. She is one of the founders of the Latin America Sepsis Institute (LASI), which is devoted to quality improvement process in Brazilian hospitals as well as to the coordination of multicentre studies in the field of sepsis. Dr. Machado joined the Editorial Board of *ICU Management & Practice* in 2016. Dr. Machado was president of LASI between 2008-2011 and vice president between 2012-2015. She is currently its CEO. She is on the executive board of the Global Sepsis Alliance and the executive committee for the World Sepsis Day and she served on the 2012 and 2016 Surviving Sepsis Campaign International Guidelines committee. She integrates the International Sepsis Forum (ISF) council since 2014, and is a member of the Executive Committee and the Scientific Committee of the Brazilian Research in Intensive Care Network (BRICNET). She tweets as @FlaviaSepsis

The recently published study on sepsis epidemiology in Brazilian ICUs is a landmark achievement (Machado et al. 2017). Please explain the key findings and significance.

Most importantly we did something that to my knowledge wasn't done before. We random sampled all Brazilian ICUs. We divided Brazil into strata, then sampled 15% of each stratum, so we had a representative sample of what's happening in Brazilian ICUs. We included 227 ICUs in this one-day prevalence study. Because of this random sampling, even though it's a one-day study, it's very strong in telling us what's going on. We showed that 30 percent of Brazilian ICU beds were occupied by patients with organ dysfunction, with sepsis, not by patients recovering from sepsis. The burden of sepsis in Brazilian ICUs is huge, and the mortality rate of these patients was 55%, very high.

Please describe your role and work with the Latin America Sepsis Institute (LASI).

I'm the CEO of LASI, working with the Board. LASI has three branches—the quality improvement programme, research, and the awareness programme where we do our World Sepsis Day activities and run an annual scientific meeting, which had 700 delegates last year. The meeting includes basic and clinical science, a multiprofessional approach, paediatrics and neonatal medicine.

In our quality improvement programmes, we train hospitals to implement sepsis protocols, we develop educational and screening tools and we have a data collections system where they can input their data. We send them quarterly reports with their performance and benchmarking with other institutions in the network. We do this for free for any hospital.

LASI at the beginning was funded from unrestricted grants from the industry. Since 2009/10 we have no direct industry grants, but they help with our scientific meeting. Now, LASI also offers consulting services to private hospitals.

How do you make sure that low- and middle-income country (LMIC) voices on sepsis are heard?

It's a challenge, but it's becoming better and the main stakeholders finally understand that we need to be heard. The most important critical care societies recognise that they need to give place and voice to LMICs. We see increased attention, such as presentations in congresses and insertion in guidelines. For example, the Surviving Sepsis Guidelines include representatives from LMICs (**survivingsepsis.org/Guidelines/Pages/default.aspx**). The World Health Organization (WHO) resolution on sepsis is a huge step, as resource-poor settings will be equally represented (**apps.who.int/gb/ebwha/pdf_files/WHA70/A70_R7-en.pdf**). There are groups in the European Society of Intensive Care Medicine (ESICM) that are working with LMICs and there are already some published guidelines on sepsis and other specific diseases.

What are the priorities following the WHO resolution on sepsis?

The key step is that WHO urged the member states to have their national plans. If WHO also develops a global action plan, as with vaccination programmes and antimicrobial resistance programmes, this will be a huge step. If a country signs this, then that country is committed to developing its own national plan. My feeling is that if it's not mandatory then the odds are that it won't happen. In the resolution there are many other important items. For example, WHO is focused also in measuring the burden of sepsis properly. They are aware we don't know the numbers and explicitly mentioned that we need better measurements. In the Global Burden of

Disease report for example, sepsis is a garbage code. People die from pneumonia, diarrhoea, but they don't die from sepsis, because infectious diseases are coded individually. The causes of death need to be coded separately but also together as sepsis.

"FOR US IN LMICS, HAVING DEFINITIONS [OF SEPSIS] THAT ARE BROADER IS IMPORTANT"

What are the major challenges in tackling sepsis in Brazil?

We don't have government policies, except for some cities and states that are now developing sepsis programmes. In the absence of government support it is too hard. Compare this with dengue that has a national programme. Every day, in newspapers, on TV, in the airport, you will see something about dengue. Because of this lack of awareness about sepsis we are struggling with all the other problems. We need to raise awareness amongst lay people. Other issues are the low awareness among healthcare professionals, lack of basic resources and ICU beds, inadequate processes of care, shortage and high turnover of staffing.

Quality improvement (QI) programmes are the focus for improving sepsis outcomes in Brazil. What are the main achievements?

We have seen lots of examples of hospitals that have achieved great mortality reduction. Many lives have been saved by these QI initiatives. Outside the LASI network, we are also seeing lots of hospitals that are implementing their own programmes. We are seeing a movement towards recognising the relevance of sepsis and having sepsis as a QI programme—hospitals are doing this regardless of what the government is doing. Many hospitals, even public hospitals, have their own protocols. This will make things easier when Brazil has its own national action plain .

What are the issues intensivists from LMICs have with Sepsis 3 and qSOFA?

I don't think there are issues with the broad Sepsis 3 definition. Having sepsis defined by life-threatening organ dysfunction associated with dysregulated response to infection is perfect. The problem is with the clinical criteria to define what is a life-threatening organ dysfunction. Using the variation in SOFA score is not adequate, because it's difficult to use, people outside the ICU hardly have heard of it, and sepsis is a major problem for the wards and EDs, for internal medicine and emergency doctors. It's just inadequate to use a score that is for the ICU. Another point is that the validation process of the SOFA score was against SIRS. We didn't use SIRS as a criterion for severe sepsis before sepsis 3. Comparing the SOFA score with SIRS makes little sense as we use any organ dysfunction, not SIRS, to define sepsis. The SOFA score will also increase specificity and decrease sensitivity. Hypotensive patients and patients with reduced level of consciousness will not be considered septic per the definition. Lactate will no longer define sepsis and we think these are important issues. For us in LMICs, having definitions that are broader is important. The issue with the Sepsis 3 definition of septic shock is that many low-income countries and some institutions in middle-income countries don't have lactate. A worldwide definition needs to be usable by everyone, so we think it should have been vasopressors OR lactate, not vasopressors AND lactate. The problem is not with qSOFA as a severity score. Our problem with qSOFA was the suggestion that it could be used as a screening tool. The JAMA figure stated that if the patient had a qSOFA score ≥ 2 you should screen for organ dysfunction (Singer et al. 2016). That suggestion caused a lot of confusion and people started to use qSOFA as a screening tool. As qSOFA has a low sensitivity we think it shouldn't be used as a screening tool.

Following the CHECKLIST-ICU study what further research is BRICNet doing?

The CHECKLIST-ICU study was a QI intervention (Writing Group for the CHECKLIST-ICU Investigators and the Brazilian Research in Intensive Care Network (BRICNet) 2016). The first author is Alexandre Cavalcanti from the Research Institute - Hospital do Coracao, São Paulo. This is a philanthropic private hospital in Brazil which has a spectacular research profile. They have a programme with the Brazilian government called PROADI and they can use part of their taxes in projects that are relevant for public hospitals. This study was done with BRICNet, the Brazilian Research in Intensive Care network. Currently we are doing together the BaSICS, which is a randomised trial comparing saline with a balanced crystalloid solution (Zampieri et al. 2017). We are also doing with Hospital Moinhos de Vento, also a philanthropic hospital, another QI study called DONORS, which is a cluster randomised trial aiming to reduce cardiac arrest in potential donors to increase organ donation. BRICNet also works with LASI in the sepsis epidemiological studies.

"Without ICU beds, who should the doctors save?" was the headline of an article in a Brazilian newspaper, and you have written very eloquently in the NEJM about the impossible choices you have to make every day and the need to promote equity in healthcare (Machado 2016). Please comment.

This is a huge problem in Brazil and certainly in many other LMICs and also in high-income countries. In Brazil, only 25% of the

population is covered by the private healthcare system. However, those who are covered by the private systems have access to 41.4 ICU beds per 100,000 population, while those covered by the public system have only 9.9 beds per 100.000 habitants. One of the key steps is to have clear rules of ICU admission. In Brazil, recently the Federal Council of Medicine published a resolution clearly stating the priorities for ICU admission, including the issues of palliative care. This will help doctors all around the country to solve the ethical dilemma. However, the issues with judicialisation will still exist. Judges order ICUs to admit patients that are not necessarily the ones we would admit if solely the priority rules would be considered. Another important issue is the absence of a clear policy for palliative care. Many times, we admit patients that we should have kept outside the ICU because end-of-life was not adequately discussed with families. Likewise, patients are kept alive in the ICU because end-of-life decisions are not discussed with the families and unjustified long periods of ICU stay precludes new admission for patients that really need ICU care. ■

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Bringing new technologies to anaesthesia

Are we there yet?

Maxime Cannesson, MD, PhD, is Professor of Anesthesiology and Vice Chair for Perioperative Medicine at UCLA. He is the Technology, Computing, and Simulation section editor for *Anesthesia & Analgesia*. His research interests focus on new technologies applied to anaesthesia and the intensive care unit.

We live in a wireless world as consumers, but wireless monitoring in the perioperative setting and the ICU is not as advanced. How will it catch up?

Do we really need to go wireless in the hospital and specifically in the perioperative setting? Intuitively it sounds like we should, because having wires to some extent is problematic for patients and there are questions about patient and clinician safety. We spend a lot of time untangling wires… but there are some risks associated with wireless technologies and cybersecurity, especially in medicine. One of the problems is an increased risk of hacking with wireless technologies, so we have to balance the benefits and risks, and issues related to cybersecurity will have to be resolved and mitigated before wireless monitoring gains widespread adoption in hospitals. Many hospitals are concerned with hacking so the imperative to wireless in medicine is less than before.

In your editorials for Anaesthesia & Analgesia you have pointed out some of the challenges in implementing technology—financial, organisational, security, risk management, fatigue, information overload, cognitive saturation. Are you optimistic despite these challenges?

I am very optimistic by nature as a person—I tend to be over-optimistic actually. There are multiple barriers to bringing new technology from the research arena into the clinical field. The main barrier is regulatory—in the U.S. the FDA regulations and in Europe the CE mark approval process; at the same time these barriers are here to protect the patient population. We don't want innovation that will hurt more patients than help. The academic community needs to understand that we have to play the rules of the regulator if we want to bring innovation to the bedside.

When new technology is approved, how do you make hospitals and healthcare workers accept the new technologies? Clinicians have a tendency to resist changes. It's interesting that many physicians tend to adopt technology outside their work, e.g. cellphones, new cars, computers, but when it comes to their own work, they tend to be protective and very territorial with technology. We can push back as much as we want, but if it's a good technology, it's going to win.

The last barrier is cost. Hospitals and medical systems have to evaluate the return on investment of the technology. New technologies have to show value, either by purely decreasing hospital costs or by improving outcome. Overall the healthcare industry is moving this way, and there is more alignment between what the hospital wants and what the industry is developing.

What do you describe as digital quality improvement? Why do you say it's not ready for widespread use? (Gabel et al. 2016)

The concept of digital quality improvement is based on the use of digital technologies to improve quality of care. The most widely disseminated technology in hospitals is the electronic medical record (EMR), which is most often used for billing and quality improvement processes. The problem is that EMRs are not very user-friendly and it's very difficult to change or design your own EMR to improve quality of care. Only 30% of hospitals have EMRs in the U.S. and Europe. When 70% of the EMR market is wide open, and industry knows hospitals are going to buy them, they don't need to have a differentiator and take a risk to get more market share. A limited number of hospitals have this expertise, and many studies have been published in the last 5 years that use EMRs to change clinicians' behaviour and improve quality. But most of these studies were conducted using custom-made anaesthesia information management systems and thus cannot be easily disseminated. Disruption will occur when clinical decision tools are made out of major vendors' EMRs so they can be disseminated from one hospital to the other.

Please explain your vision of a "data mart" to collect process and outcome metrics in real time about perioperative care (Cannesson et al. 2015). Will this enable a move from "big data" to "smart data"?

When we are working in hospitals where the EMR is implemented we have data. The hospital leaders—the department chairs, CMOs, CEOs and chief quality officers—know the data is here, but very few places have actually

accessed the data from the EMR. We understand that these data have a lot of value, because using the data we can display outcomes and look at the process of care—what we do well and what we don't do so well. At UCLA, where we have 150 anaesthesiologists, we took the strategic decision to dedicate some of our medical time and finances to have an IT team within the department to develop a data warehouse from the EMR. We have 1.5 FTE anaesthesiologists and 1 full-time engineer employed on the data warehouse.

We own the data, we have access and the expertise on how to handle data and share data with other departments. After 3-4 years of this development the department of anaesthesiology is becoming the hub for data sharing at the healthcare system level, and other departments are coming to us. It puts the department in a very strong position. There is no doubt that hospital leadership and clinicians will want more and more data to drive strategy and decide what to invest in.

How do you overcome issues of data quality in a data warehouse project?

You need to define the source of the data by consensus, otherwise depending on the data source you are using to measure the outcome, you are going to come up with very different incidence. You need to be smart and cognisant of the limitations.

What are your thoughts on the concept of perioperative medicine?

Our motto is very simple: Excellence of care is not lacking in our western healthcare systems. We have access to the best technologies, we have the best-trained physicians, and we have brand new and efficient therapeutics. When a patient experiences a bad outcome, it is not because excellence of care is not available. Bad outcomes happen because care is not coordinated efficiently. Perioperative medicine is becoming a hot topic, because over the past 15 years anaesthesiologists and surgeons have made the operating room (OR) the safest place in the hospital even though it's the place where you take the most risks. Today we have the lowest complications associated with anaesthesiology, and when there are complications in the OR usually we can take care of it. Mortality today in the OR is close to zero. When surgical patients have complications it happens because of a lack of optimisation before surgery or because they develop complications in the postoperative period. In essence, complications happen because of a lack of coordination and because of disjointed care. What we are proposing in perioperative medicine is to optimise the care of patients undergoing surgery. The idea is to take anaesthesiologists, surgeons, internal medicine, nursing and IT and help redesign care in the perioperative setting to make it better coordinated. It's also a way for specialities to change their value proposition.

"THE HUMAN PART THAT WE HAVE AS DOCTORS—NO MACHINE CAN REPLACE IT"

What are the promises and the challenges of closed-loop systems in anaesthesiology?

The closed-loop system is a shift in paradigm. Today anaesthesiologists in the OR are more focused on the process of care, whereas what we should do is set targets—for example I want to keep mean arterial pressure at 70 mmHg, I want to keep cardiac output at 4.5 litre per minute, I want to have a Bispectral Index (BIS) value between 40 and 50. That's the value we bring—it's not delivering the care, it's setting the strategies. It has been demonstrated that there is a lot of variability in the care we provide from one practitioner to the other, so the idea is to use closed-loop systems to try to help us be more standardised in care delivery. A closed-loop system is a good way to do it, as it makes the link between monitors and the drug infusion devices. The idea is that the clinician sets the goals of clinical management and the automated system delivers the care, like when you set the room temperature and use the air conditioner to maintain the temperature. It's very likely that in the future intraoperative care is going to be delivered more and more by mid-level providers, such as nurse anaesthetists. We will have MD-anaesthesiologists work more either on high acuity care, or outside of the OR. How can we use technology to help us keep control of medical management? These technologies will be like care extenders or midlevel providers, and anaesthesiologists will be able to focus their attention on other things. It's an opportunity, as we don't need MDs to do very mundane tasks in the OR. We need physicians to talk to the patients and family, to make shared informed decisions with the patient, and coordinate the care of the surgical patients. The human part that we have as doctors—no machine can replace it.

Should videolaryngoscopes be the first choice for intubation?

It's a matter of time that they will be used for all cases. When technology arrives to replace an old one, the new technology ends up cannibalising the old one, but it's not instantaneous, it takes time. It creates some generational gaps, when physicians who have been using the old technology complain that new trainees are not going to be able to use old technologies, but that's the nature of things.

However, we have to be mindful not to over emphasise that a new technology is superior to an old one, because in most cases old ones are much cheaper and we need to make sure that people have access to these old technologies. ■

References

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28-30	ATHENA 2017 International Conference Athens, Greece **https://iii.hm/d8x**

DECEMBER

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6-8	23rd Postgraduate Refresher Course on Cardiovascular and Respiratory Physiology Applied to ICM Brussels, Belgium **https://iii.hm/d90**
6-9	Emirates Society of Emergency Medicine Scientific Conference Dubai, UAE **https://iii.hm/d91**
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JANUARY

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19	Critical Care Reviews Meeting 2018 Belfast, **UK https://iii.hm/efy**

FEBRUARY

15-16	23rd International Symposium on Infections in the Critically Ill Patient Dublin, Ireland **https://iii.hm/d94**
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MARCH

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17-21	5th SG-ANZICS Asia Pacific Intensive Care Forum Singapore **https://iii.hm/egb**
23-26	7th EuroELSO Congress on ECMO-ECLS Prague, Czech Republic **https://iii.hm/eip**

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