ICU MANAGEMENT

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COST-EFFECTIVENESS

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Presenters

The Evolving Role of Cardiorespiratory Monitoring: Importance of Oxygen Delivery in Acutely Ill Patients

Jean-Louis Vincent, MD, PhD

Professor of Intensive Care Medicine (Université Libre de Bruxelles)
Department of Intensive Care, Erasme University Hospital
President, World Federation of Intensive and Critical Care Societies (WFSICCM)

Volumetrics: New Paradigms in Fluid Optimization and Blood Management

Aryeh Shander, MD, FCCM, FCCP

Chief Department of Anesthesiology
Pain Management and Hyperbaric Medicine
Englewood Hospital and Medical Center
Clinical Professor of Anesthesiology
Mount Sinai School of Medicine
Mount Sinai Hospital, New York

The Elderly Brain During General Anesthesia and Emergence – From Neurobiology to Electroencephalography

Emery N. Brown, MD, PhD

Warren M. Zapol Professor of Anesthesia
Massachusetts General Hospital / Harvard Medical School
Edward Hood Taplin Professor of Medical Engineering
Professor of Computational Neuroscience
Massachusetts Institute of Technology
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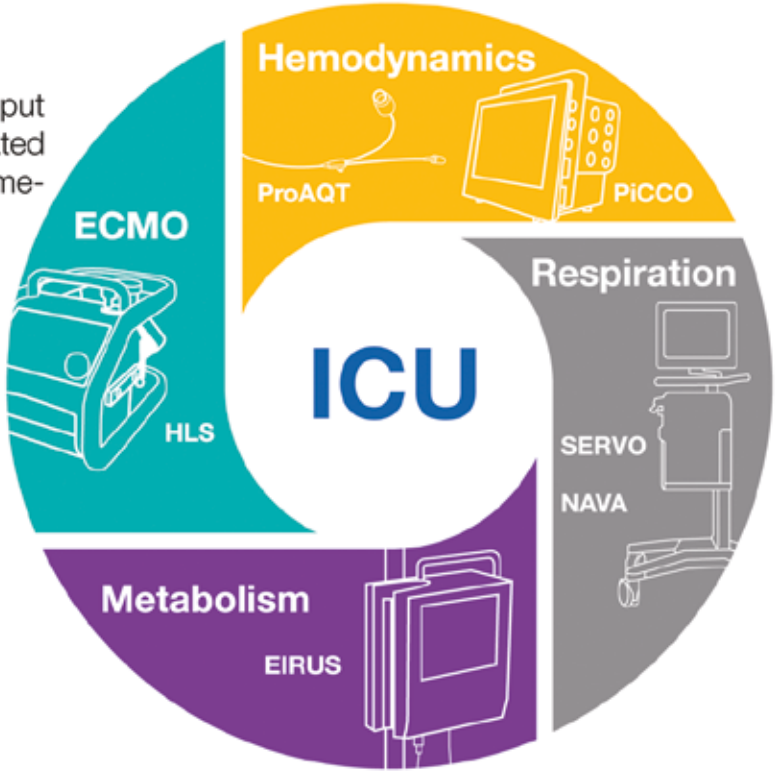

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This document is intended to an international audience outside of the US.

COST-EFFECTIVENESS

In medicine the benefits of treatment are always weighed against possible harms. In these times of budgetary constraints financial considerations also come even more into focus. Cost-effectiveness in medicine works at many levels. In clinical trials the cost of quality-adjusted life years (QALYs) may be one of the outcomes measured. At a department or hospital level, directors need to consider the cost-effectiveness of staffing, procedures or prescribing practices, for example. Cost-effectiveness is pertinent when looking at introducing new treatments, but it is also a tool to evaluate existing treatments and procedures.

In the first article in our cover story Diana Lebherz-Eichinger, Barbara Gutenbrunner, Albert Reiter, Georg A. Roth, Christian J. Herold and Claus Krenn write about their study of the economic impact of omitting routine chest radiographs (CXR) in a university ICU. They also conducted a prospective observational micro-costing exercise to identify the current costs of radiodiagnostic pathways, and compared the CXR cost calculation between a university hospital and a regional hospital ICU. They argue that routine procedures should be evaluated on their contribution to diagnosis, economic aspects and the patients' benefit, and that cost calculations should be regularly adapted to reflect reality. Staying with imaging, next Diku Mandavia argues the case for ultrasound-guided needle procedures. He explains that ultrasound guidance may significantly reduce serious adverse events and the cost of care in patients.

In the Matrix section, Maarten Nijsten and Jan Bakker explain that the use of lactate measurements in critically ill patients is at a level where in some cases it may be considered lactate monitoring. They discuss the central metabolic role of lactate in animal metabolism, why lactate is mainly a marker of stress and how this translates into its unique diagnostic utility in many acute conditions. They also look to a future role for computerised lactate decision support. Next, Jacqueline Pflaum-Carlson, Jayna Gardner-Gray, Gina Hurst and Emanuel P. Rivers review early sepsis management, concluding that the question remains whether an invasive or noninvasive method (with or without central venous pressure) confers improved mortality. Last, Heidi Wimmers writes about the comprehensive traceability system for drugs that her hospital implemented, thus increasing the protection of patients from falsified, expired or recalled medicine.

In our Management section Alessandro Barelli, Roberta Barelli, Antonio Gullì and Massimo Antonelli describe the role of simulation in intensive care education and training. Next, Peter Brindley explains the basics of communicating about difficult medical decisions and outlines the communications tools and bundles that can provide structure and reliability to complex communication. He cautions, however, that they should never make interactions robotic and devoid of personal connection.

Paul E. Pepe is interviewed for this issue. He looks back on 35 years of public service in emergency medicine and the innovative research he has conducted. He also expands on his mantra "a gram of good pre-hospital care saves a kilogram of ICU care" and what the definition of success is for an ICU director.

In my role as President of the World Federation of Societies of Intensive and Critical Care Medicine (WFSICCM), I am looking forward to meeting many of you in Seoul for the WFSICCM congress from 29 August – 1 September (an interview on this role is on page 92). Korea is well-known for the quality of its healthcare and contribution to the medical literature, and we are delighted to feature Korea as our Country Focus. Dong Chan Kim, President of the Korean Society of Critical Care Medicine (KSCCM) and Sungwon Na, Secretary General of the KSCCM outline the past, the present and the future of critical care medicine in Korea. Dong Chan Kim with Sang-Min Lee, Director of Academic Board of the KSCCM write about hot topics in Korea, including the variance of ICU treatment among institutions and the recent quality assessment that should improve the quality of ICU care further.

As well as our Agenda listing upcoming intensive and critical care congresses, we include an interview with Roger Harris from smacc (social media and critical care), whose 3rd congress will be held in Chicago from 23-26 June.

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

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ICU Management

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Study Provides Guidance for ICU Staffing

The findings of a new study examining the ratio of nurse practitioners (NPs) and physician assistants (PAs) to patients may help hospital administrators better determine appropriate staffing levels in ICUs. Published in the *American Journal of Critical Care* (*AJCC*), "Patient-to-Provider Ratios for Nurse Practitioners and Physician Assistants in Critical Care Settings: Results From a National Survey" is the first national study to report on advanced practice provider-to-patient ratios in ICUs and other acute and critical care settings. The study was funded by the American Association of Critical-Care Nurses (AACN) through an Impact Research Grant, which supports clinical inquiry that drives change in high acuity and critical care nursing practice.

The researchers collected 433 responses via an online survey of NPs and PAs who are members of the American Association of Nurse Practitioners, American Academy of Physician Assistants or the Society of Critical Care Medicine and practise in the U.S. and Canada.

Average provider-to-patient ratios reported were:

- ICUs - 1:5 for both NPs and PAs;
- Paediatric ICUs - 1:4 for NPs;
- Critical care settings that integrated fellows and medical residents - 1:4 for both NPs and PAs.

The researchers noted that the key factors that impact patient-to-provider ratios are the severity of the patients' illnesses, the number of patients in the unit and the number of providers in the unit. Other factors include patient diagnosis, the number of physicians in the unit, time of day and the number of fellows and medical residents on service.

To find out more about the study, *ICU Management* spoke to lead author, Ruth Kleinpell.

Ruth Kleinpell, RN-CS, PhD, FCCM

Why was it important to gather this data and how will it help future planning?

More organisations are hiring NPs and PAs to assist in the management of acute and critically ill patients as part of team-based care in the ICU. However, information is lacking on how NP and PA roles in the ICU are being developed and implemented, including the number of patients they are overseeing as part of their roles in the ICU. The information provided in the survey can help ICU directors and others better develop staffing models and structure roles for NPs and PAs in the ICU to work in conjunction with the intensivist-led team.

Integrating NPs and PAs on the ICU team and assigning appropriate workloads can ensure optimal care for ICU patients as well as promote recruitment and retention of qualified NPs and PAs. Their roles also promote continuity of care as, unlike rotating physicians, resident or fellows, their consistent presence in the ICU can help to promote high quality care; promote patient, family and staff education; facilitate discharge planning; and improve quality of care in the ICU.

What are the next steps in establishing optimal ratios for ICUs for NPs and PAs and the factors that affect these ratios?

Additional information is needed about NP and PA roles in the ICU. While the results of the study indicate that on average, they are helping to manage between 3 and 5 ICU patients, other factors that need to be considered include the patient's severity of illness, the number of patients in the ICU, the number of providers in the ICU, the patient's diagnosis and care needs, and the number of ICU admissions and discharges that may be occurring at the same time, among others.

Is there any potential conflict between the roles of PAs and NPs? As NPs already have established educational routes in critical care, should PAs have a similar educational programme?

The roles of the NPs and PAs are not in conflict but are rather complementary. As advanced practice providers they similarly assist the intensivist-led team to manage patients in the ICUs. However, their roles may vary in that PAs may have a role in assisting in the operating theatre or in performing procedures while the NP may also have a role in providing education to the family and nursing staff, implement quality improvement or research initiatives, or work on unit based guidelines. Working together with other members of the ICU team, NPs and PAs help to meet the workforce needs in the ICU.

The expansion of NPs and PAs was a response to duty hours regulations for physicians. Are existing regulations sufficient on when and where to employ NPs and PAs in the ICU?

The resident duty hour restrictions are one factor that has led to increased use of NPs and PAs in the ICU. Other factors have included increased patient acuity levels; complex care needs requiring care management and oversight; the need to focus on improving quality of care metrics in the ICU such as decreasing infection rates; implementing guideline-based care, for example deep vein thrombosis prophylaxis or other care measures; and providing continuity of care.

You write that "ensuring appropriate scope of practice is an essential aspect of utilising NPs and PAs in the ICU." How should scope of practice be addressed, for example in education and training, by professional associations, regulatory bodies or individual ICUs?

Scope of practice is designated by the NP and PAs' education and training. In the United States, master's degree education is required and some are seeking clinical doctorate level training in programmes that specifically focus on acute and critical care. Additionally, national certification is a requirement for most U.S. states for NP practice, with NPs receiving certification as an acute care NP to work in the ICU. PAs can seek a certificate of added qualification, commonly in emergency medicine, surgery or hospital medicine as one does not currently exist for critical care. While a hospital's credentialing and privileging process impacts NP and PA scope of practice, individual ICUs do not designate scope of practice. National credentialing boards and professional association specialty competency guidelines are an additional reference source for defining scope of practice.

Reference

Kleinpell R, Ward NS, Kelso LA et al. (2015) Provider to patient ratios for nurse practitioners and physician assistants in critical care units. Am J Crit Care, 24(3): e16-e21.

Reducing the Risk of Recurrence of C. Diff Infection

A study published in JAMA has shown that drinking a non-toxic strain of *Clostridium difficile* bacteria could help reduce the incidence of recurrent infection caused by the toxic strains of the bacteria.

C. difficile is the most common cause of healthcare-associated infection in U.S. hospitals, and recurrence occurs in 25 to 30 percent of patients. Toxic strains of *C. difficile* bacteria cause diarrhoea, abdominal cramps and, in some cases, severe inflammation of the colon. The infection commonly affects people during or after a hospital stay, particularly those who have had a long course of antibiotics or have a weakened immune system.

"The antibiotics don't completely get rid of the *C. diff* bacteria, and if the patient hasn't developed an immune response against the toxin the bacteria produces, they'll get sick again," explained lead author Dale Gerding, MD, professor of medicine at Loyola University Chicago Stritch School of Medicine.

In this trial, after patients were successfully treated with an antibiotic, the researchers gave them a non-toxic strain of *C. difficile*, theorising that the good bug would crowd out what remained of its toxic cousin. 173 patients (18 years or older) were randomly assigned to four groups: three that received different doses of non-toxic *C. difficile*, and one that was given a placebo. The good *C. difficile*, Dr. Gerding noted, is completely natural. Treatment involved drinking a colourless, odourless liquid once a day, for one week.

Of 125 patients who received the treatment, only 11 percent had a recurrent infection within six weeks. Notably, a subgroup that was given a relatively higher dose of the good bug fared even better: only two of 43 patients (5 percent) suffered another infection. Patients on the therapy had headaches more often than the placebo group, but there was no evidence of serious risks, the research team noted.

After treatment, the good *C. difficile* bacteria "don't stay around forever," Dr. Gerding said, adding that the therapy may set the stage for patients' normal balance of gut bacteria to flourish again.

In an interview with *ICU Management* Dr. Gerding explained that non-antibiotic treatment was the focus as the antibiotics used to treat the *C. difficile* infection leave the patients susceptible for reccurrence because they disrupt the normal bacteria in the gut. A mechanism for treating it was needed that doesn't affect the other bacteria in the gut so the study substituted the non-toxigenic strain for the toxigenic strain, getting the gut colonised with the non-toxigenic strain and then preventing patients from having the reccurrence.

Dr. Gerding confirmed that a phase three trial is planned to look at the optimal dose and duration of the therapy. Looking to the future, as it is easy to identify who is most at risk of C. diff infection, treatment would simply be an adjunct treatment to prevent patients getting a recurrence and ultimately for primary prevention.

Reference

Gerding DN, Meyer T, Lee C et al. (2015) Administration of spores of nontoxigenic clostridium difficile strain M3 for prevention of recurrent C difficile infection: a randomized clinical trial. JAMA, 313(17): 1719-27.

OMITTING ROUTINE CHEST RADIOGRAPHS IN INTENSIVE CARE UNITS

THE ECONOMIC IMPACT

We studied the economic impact of omitting routine chest radiographs (CXR) in a university ICU. Additionally, we performed a prospective observational micro-costing exercise to identify the current costs of radiodiagnostic pathways, and compared the CXR cost calculation between a university hospital and a regional hospital ICU.

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Anteroposterior chest radiographs (CXRs) are often obtained daily from patients in intensive care units (ICUs) in addition to a physical examination (Godoy et al. 2012; Trotman-Dickenson 2003). The detection of complications associated with indwelling devices as well as the timely recognition of cardiopulmonary afflictions can lead to earlier treatment of clinically unsuspected problems. Therefore various guidelines recommend routine CXRs, especially in patients receiving mechanical ventilation or suffering from acute cardiopulmonary disorders (Amorosa 2008). In contrast, a more restrictive approach limits CXRs to specific clinical indications like placement of indwelling devices or a change in the patient's respiratory status (Clec'h et al. 2008; Graat et al. 2006; Graat et al. 2007; Hejblum et al. 2009; Hendrikse et al. 2007; Krivopal et al. 2003; Silverstein et al. 1993). Those studies have questioned the medical benefit of routine CXR in ICU patients. Furthermore, restrictions in performing CXRs in ICUs may help to decrease healthcare costs, reduce radiation exposure, and avoid unnecessary treatment of minor or false positive findings (Brainsky et al. 1997; Fong et al. 1995; Hendrikse et al. 2007; Krivopal et al. 2003; Leppek et al. 1998; Price et al. 1999). Also the positioning of critically ill patients can lead to adverse events like malpositioning of devices, which also can be minimised by the strict limitation of radiographs to particular clinical indications (Boulain 1998).

Economic and clinical costs associated with routine CXRs have to be taken into account. In general, avoidable costs should be minimised, without limiting diagnostic quality, to ensure an optimal distribution of financial resources. Hence the omission of routine CXRs in ICUs can lead to substantial cost savings without degrading the quality of medical care (Price et al. 1999). The aim of this study was to analyse the real costs of radiodiagnostic pathways in ICUs and investigate the potential cost savings due to the elimination of routine CXRs and the restriction of radiographs to specific clinical indications.

Materials and Methods

Study Design

The study was planned in three parts. First we performed a prospective observational micro-costing exercise for one week in five ICUs at the university hospital of Vienna, Austria, to analyse the current costs of radiodiagnostic pathways. During this period daily routine CXRs were obtained from every patient admitted. The requirements of personnel and consumable materials to obtain radiographs were assessed and compared with the corresponding cost accounting. Through pathway construction each process of radiodiagnostic examination (RDE) was individually analysed in order to charge overall costs by activity-based costing. Secondly, the application and costing of CXRs in the university hospital and a regional hospital (Landesklinikum Amstetten, Lower Austria, Austria) were compared to reveal differences in CXR cost accounting and application management. Thirdly, we analysed cost savings due to elimination of daily CXRs in a university ICU, including data on all admitted patients, six months before and six months after routine CXRs were eliminated. All costs are given in Euros.

Study Locations

The micro-costing study was conducted in five ICUs of the university hospital of Vienna, Austria. Each ICU is an 8-bed closed-format department (4 sickrooms each) in which

medical and surgical patients (including cardiothoracic surgery and neurosurgery patients) are under the direct care of the ICU team. During daytime the patients of one ICU are under the observation of up to two ICU physicians and residents. At night or at the weekend the on-call ICU team comprises one ICU physician and one resident.

In Amstetten hospital the ICU is an 8-bed closed-format department with medical and surgical patients. Cardiothoracic surgery and neurosurgery are not performed in this hospital. The ICU team comprises one physician and one resident during the day and one physician during the night or at the weekend.

Micro-costing

To estimate the costs of RDEs in university ICUs each process was individually analysed by activity-based costing. The personnel requirement as well as the consumable material was reported via questionnaires, which were completed for every obtained CXR by the staff involved. This observational phase was conducted over one week in five ICUs at the university hospital of Vienna, Austria. At that time daily routine CXRs were standard procedure and the data were collected for every patient receiving a CXR within the study week, including repeated radiographs for the same patient. The questionnaires comprised the number and the qualifications of all involved employees as well as the consumable material used and the time needed to obtain the individual CXRs (including the time needed to cart the mobile x-ray apparatus from the base to the first ICU, from one unit to another and between sickrooms). The patients' diagnosis and treatment, including respiratory status and extracorporeal circuits, were documented separately. Patients suffering from infectious diseases were described in particular, due to the increased effort to obtain the CXR. Further, the time needed to examine every individual radiograph, including the diagnosis and discussion with the ICU physician, was documented by the radiologist on duty. The data retrieved was compared with the correspondent in-house cost accounting.

Before–After Study

Between January and June 2010 the number of CXRs was retrospectively assessed for all patients in one university ICU as well as in the ICU in the tertiary hospital of Amstetten. The number of treated patients, their length of stay and intensive scores were collected and compared between locations. At that time daily CXRs were standard procedure in the university ICU, and for ventilated patients only in Amstetten.

In the second half-year period, CXRs in the university ICU were limited to specific indications, e.g. the insertion of indwelling devices, an increase in oxygen requirement, or in pulmonary secretion. CXRs at admission were conducted only if in the short-term no previous radiograph was available or after insertion of central venous lines. Daily CXRs were performed in accordance with the guidelines of the Royal College of Radiologists (2003). For this period the number of CXRs and the patients' data were also collected as for the first half-year 2010. Furthermore, the number of computed tomography (CT) scans on demand was assessed separately for the two periods in order to assess a potential change in the usage of other imaging techniques.

> "Restrictions may help to decrease costs, reduce radiation exposure and avoid unnecessary treatment of minor or false positive findings"

Statistical Analysis

Demographic data were extracted from the ICU databases. Data are expressed as mean and standard deviation unless otherwise stated. Statistical analysis was performed with GraphPad Prism Version 5.01 (GraphPad Software, Inc. San Diego, CA, USA). Demographic data of patients admitted to Amstetten or to the university ICU in the second half-year 2010 were statistically compared to patients admitted to the university ICU in the first half-year 2010. The numbers of patients in the patients' subgroups, the numbers of survivors,

	Regional hospital	University hospital	
	first half-year	first half-year	second half-year
No. of patients	80	248	258
No. of patients per bed	10	31	32
Age (years, mean, SD)	63 (19)	60 (16)	57 (18)
Gender male (*n*, %)	49 (61%)	146 (59%)	168 (6 %)
Length of stay/ patient in ICU (days, SD)	12.7 (14) **	5.8 (6)	5.6 (9)
SAPS II score (mean, SD)	31 (13.2)	32.9 (13.6)	32.2 (15.1)
Non-survivor (*n*, %)	25 (20%)**	17 (7 %)	25 (1%)
No. of CXRs	751	1254	828
CXRs per patient	9.4	5.1	3.2
CXRs per patient per day	0.7	1.1	0.6
Estimated costs per CXR (Euro)	23.36	54.30	54.30
Costs for CXRs/ patient (Euro)	218.7	274.6	174.3
Costs for CXRs/ patient/day (Euro)	19.2	57.2	34.2
No. of CT		145	97
Patient subgroups			
Medical (*n*)	30*	50	56
Cardiovascular surgery (*n*)	2	21	22
Neurosurgery (*n*)		11	6
Thoracic surgery (*n*)		12	11
Transplantation (*n*)		11	9
Trauma (*n*)	28**	23	20
Gastrointestinal surgery (*n*)	20*	32	46
Other (*n*)		49	60
Unknown (*n*)		39	28

Table 1. Demographic Data

Asterisks depict the significance compared to data of the university hospital in the first half-year (* $p < 0.01$; ** $p < 0.001$). The patients did not differ significantly in age, sex or SAPSII score between all compared groups. The patients admitted in the first and the second half-year 2010 to the university ICU did not differ between the patients' subgroups or mortality.

SAPS II, Simplified Acute Physiology Score; CXR, Anteroposterior chest radiographs.

and the number of males/females were compared with X^2 analysis, with $p < 0.05$ considered significant. The patients' age and SAPSII score as well as their length of ICU stay were analysed with the two-tailed Mann-Whitney U test, with $p < 0.05$ considered significant.

Results

Micro-Costing

During the study period the time to obtain a CXR was measured for 46 patients, and the examination time was documented for 41 patients by the radiologist on duty. 19 patients were mechanically ventilated via tube and five patients were infected with a multiresistant pathogen. Every CXR was obtained by a technician. If the patient was mechanically ventilated additional help from the nursing staff present were necessary. The examination and discussion was conducted by a resident of radiology and a resident of intensive care medicine. However, the official in-house cost accounting considered a technician to obtain the CXR as well as an assistant, whose help was essentially not required. On the contrary, the intervention of the nursing staff was not accounted for. The official cost accounting included one medical doctor to examine the CXR, without appraisal of his/her qualifications.

The account of time taken shows that all radiodiagnostic measures within one university ICU lasted 24 minutes and the examination for all patients within one university ICU 13 minutes.

The finance department computed the following working time for one CXR: 25 minutes for a technician, 5 minutes for a medical doctor and 10 minutes for an assistant, whose help was essentially not required.

The consumable material to obtain CXRs from non-infectious patients comprised disinfection material, disposable gloves and aprons. For patients suffering from multiresistant pathogens surgical masks, surgical caps, surgical coats, and wrapping for the x-ray film cartridge were additionally needed. The official cost accounting deemed an x-ray film per CXR - although the CXRs were already saved digitally at that time - but no further consumable material necessary.

University hospital versus regional hospital

Within the same time period 78 patients were admitted to the regional ICU versus 248 patients in the university ICU. The patients were comparable in age, sex, and severity of disease, but differed in length of stay and mortality (see Table 1).

Amstetten charged 23.36 Euro per CXR consisting of 10 minutes working time for two technicians, consumable material, initial costs as well as costs of upkeep, administration, and electricity. The medical examination was not accounted. In the university hospital, the finance department estimated a charge of 54.30 Euro per CXR, which included the medical examination.

Additional costs, such as depreciation of capital goods like the radiologic scanner, the printer or the x-ray viewing screen, were not specified in both hospitals. Unlike the university hospital, the finance department in Amstetten differed between CXRs obtained from ICU patients or out-patients. Daily costs for CXRs per patients accounted for 19.2 Euro in the regional hospital in contrast to 57.2 Euro in the university hospital. Charges for one patient amounted to a total of about 200 Euro in Amstetten versus 270 Euro in Vienna.

Before-after study

In the first half-year 2010 (1 January-30 June) 1254 CXRs were obtained from 248 patients in the university ICU (see Table 1). In the second half-year (1 July-31 December) daily routine CXRs were abandoned and radiographs were limited to specific indications. During this period 828 CXRs were obtained from 258 patients, a reduction of 34%. From January till June 5.1 CXRs per patients were performed, versus 3.2 from July till December. Apparently the reduction of radiographs had no effect on the patients' mortality or length of ICU stay (see Table 1). Since real costs could not be determined by our study the charges set by the finance department were used for cost saving calculation. As 54.30 Euro were estimated per CXR by the finance department, the decreased usage of radiographs led to a calculated cost reduction of about 23,000 Euro. The daily costs for radiographs per patients per day dropped from 57 Euro to 34 Euro. Total cost savings amounted to about 100 Euro per patient (see Table 1). Interestingly, the number of demanded CT interventions also decreased from 145 in the first half-year to 97 in the second half-year, leading to a calculated cost reduction of about 13,500 Euro, as 280.11 Euro were charged per CT examination by the finance department.

> "Routine procedures should be questioned on their contribution to diagnosis, economic aspects, and patients' benefit"

Discussion

CXRs are frequently obtained daily to early detect cardiopulmonary complications in patients admitted to ICUs. In contrast, recent publications question the diagnostic and clinical value of routine RDEs (Clec'h et al. 2008; Graat et al. 2006; Graat et al. 2007; Hendrikse et al. 2007; Kappert et al. 2008; Price et al. 1999). Those studies demonstrated that daily CXRs rarely reveal clinically relevant abnormalities. Furthermore, the omission of routine CXRs had no effect on the patients' outcome or readmission rate, but led to cost savings and economic benefits. Clec'h et al. were even able to demonstrate that the restrictive usage of CXRs was associated with better diagnostic and therapeutic efficacy than daily routine use (Clec'h et al. 2008). Based on those findings we analysed the financial impact of omission of routine CXRs in a university ICU. Further, we investigated each process of RDEs via pathway construction and compared the cost calculation with real time and effort measured.

In most European countries healthcare costs are usually not borne by the individual patient but by health insurance. As a consequence, economic pressure to change routine examinations is barely present as long as the patients' security is assured. Due to daily changes in medical personnel, routine CXRs have been standard procedure in our department in order to compensate for potential deficits in medical handover. Because of emerging economic pressure, traditional procedures like routine RDEs have been increasingly questioned, leading to the

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omission of daily CXRs in our ICU. As a result, the limitation of RDEs to defined clinical indications caused a reduction of radiographs of 34% within six months. Thereby the analysed before and after patient cohorts were comparable, with no statistical significance in age, sex or severity of illness. In accordance with the literature we also could not observe any differences in mortality or in length of ICU stay attributed to the omission of daily CXRs. Since daily radiodiagnostic controls were not available any more, the number of ordered CT interventions might subsequently have been increased in order to overcome this limitation. Interestingly the number of CT examinations even decreased, which is in accordance with the study of Kröner et al., who showed that limitation of daily radiographs had no impact on number or implication of CT and ultrasound examinations (Kroner et al. 2008).

The omission of daily routine CXRs in the university hospital led to calculated cost savings of about 23,000 Euro within six months for one 8-bed ICU. Daily CXR charges per patients were reduced by half, resulting in an overall cost saving of about 100 Euro per patient. This is in accordance with Price et al., who also demonstrated the financial impact of an evaluation and subsequent change in CXR ordering practice in a paediatric ICU, leading to fewer radiographs per patients and consequently to cost reduction (Price et al. 1999). The reduced demand of CT examinations in our ICU resulted in cost savings of about 13,500 Euro for a time period of six months.

Our analyses of RDEs by activity-based costing via pathway construction revealed a mismatch between accounted and real costs. We demonstrated that RDEs in ICUs are less time-consuming than expected, even when the patients were mechanically ventilated or infectious. Working time, the most important cost item, was overestimated in the official cost calculation by about 90%. This difference in charged and real working time might derive from preset values, which have been used for cost calculations. Although radiographs were saved digitally at time of investigation, the cost accounting still calculated CXR costs based on x-ray films but no consumable material, energy costs or additional charges. Thus, accounting costs do not correlate with real effort, but unfortunately we were not able to ascertain real costs within this study.

In the regional hospital CXR cost calculation differed from the university hospital. Cost accounting in the regional hospital was more accurate and even differentiated between patients admitted to ICUs and outpatients. In contrast, medical appraisal of findings was not considered in CXR cost calculation. In the regional as well as in the university hospital charges for capital goods such as the radiologic scanner, the printer and x-ray viewing screens were not accounted for in CXR cost calculation and might therefore have been included elsewhere. In the regional hospital, daily CXRs were standard procedure for ventilated patients only, whereas for other patients RDEs were restricted to clinical indications. The patient population was comparable in age, sex, and severity of disease, but differed in patient subgroups and consequently in length of ICU-stay and the patients' mortality. Due to their longer hospitalisation, patients in the regional hospital received more CXRs.

Conclusion

Our study demonstrates the substantial impact that changes in routine tests and clinical management may have on economic costs. Therefore routine procedures should be regularly questioned on their contribution to diagnosis, economic aspects and the patients' benefit to enable an optimal distribution of resources. Moreover, cost calculations should be regularly adapted to reflect the real use of resources. ■

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ULTRASOUND-GUIDED PROCEDURES

FINANCIAL AND SAFETY BENEFITS

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Ultrasound Guidance Improves the Safety and Success of Needle Procedures

The European Prevalence of Infection in Intensive Care study reported that 78% of critically ill patients had a central line inserted, while several million central venous catheters (CVCs) a year are placed in American hospitals (Gibbs, 2006). Since this common procedure can have serious risks, including accidental puncture and collapse of the patient's lung (iatrogenic pneumothorax), arterial injury, haemorrhage and even death (Bowdle, 2014), it is crucial that the catheter be placed correctly, with as few attempts as possible.

Traditionally clinicians have used anatomic 'landmarks' to estimate where the target blood vessel lies below the skin. However, this method can be unsuccessful in up to 35% of cases (Bernard 1971; Defalque 1974; Sznajder 1986), with complication rates of up to 19% reported in the literature (Merrer 2001). Moreover, 9% of patients have anatomic abnormalities of their central veins, making CVC placement difficult, dangerous or even impossible (Denys 1991).

Ultrasound guidance allows clinicians to see their anatomical target and surrounding structures, such as soft tissue, vessels and nerves in real time as the needle advances to the procedure's endpoint, instead of working blindly. In addition, ultrasound visualisation can also help clinicians assess the patency and diameter of the target vein.

Ultrasound Helps Reduce Procedural Errors and Costs

Central line-associated bloodstream infections (CLASBIs) and pneumothorax rank among the six most expensive medical errors (Van Den Bos 2011). According to the Centers for Disease Control (CDC), about 250,000 CLASBIs infections occur each year in the United States with attributable mortality estimated at 12 to 25% and attributable cost estimated to range as high as $56,000 per infection (O'Grady 2011; O'Grady 2002). Collapsed lung increases length of hospital stay by 4 to 7 days at an additional cost of up to US$45,000 per case (Zhan 2004).

Yet there are proven safety practices to reduce or even eliminate these serious, but preventable complications. In a randomised controlled trial (RCT) of 900 critical care patients, ultrasound-guided CVC placements in the internal jugular vein lowered rates of pneumothorax to zero percent, compared to a rate of 2.4% for landmark methods (Karakitsos 2006). The study also reported the following outcomes:

- A 100% success rate with ultrasound-guided CVC placement, compared to 94.4% in the landmark group;
- A 0.6% rate of haematoma with ultrasound, versus 8.4% without it;
- A 1.1% rate of accidental carotid artery puncture with ultrasound, versus 10.6% with landmark methods;
- The ultrasound arm also had significantly reduced blood vessel access time, higher first-pass success, and a 35% lower rate of central line-associated bloodstream infection (CLASBI).

Similarly, in a recent RCT of ultrasound versus 'blind' landmark technique for placement of subclavian lines, patients whose CVCs were inserted under real-time ultrasound guidance had zero percent rates of pneumothorax and haemothorax, compared to rates of 4.8 and 4.4 % in the landmark group (Fragou 2011). All other adverse events were also reduced or eliminated when ultrasound visualisation was used. In this cohort of critical care patients, successful cannulation was achieved in 100% of the ultrasound group, compared with 87.5% of the landmark arm.

Based on these outcomes, an accompanying editorial by Andrew Bodenham suggested that, "there is now enough evidence for the benefits of ultrasound for it now to be considered unethical to continue to submit patients to the risks of landmark techniques for research practice if ultrasound guidance is available at that hospital" (Bodenham 2011).

A Cochrane systematic review by German and British researchers found striking safety benefits for ultrasound-guided CVCs of the internal jugular vein (Brass 2015), compared to the landmark method. Key findings from an examination of pooled data from 35 studies involving 5,108 participants included the following reductions in adverse events and improvements in procedure success in the ultrasound group:

- 71% reduction in total complications (14 trials, 2,406 participants);
- 72% reduction in accidental arterial puncture (22 trials, 4,388 participants;
- 73% decrease in haematoma formation (13 trials, 3,233 participants);
- 57% higher first-attempt success rate (18 trials, 2,681 participants);
- Significantly faster time to perform the procedure.

Indeed, the safety data is so overwhelming that in 2002 the United Kingdom's National Institute for Health and Clinical Excellence (NICE) formulated guidelines advising ultrasound guidance as the preferred method to lower the risk of iatrogenic pneumothorax, arterial puncture, arteriovenous fistula, nerve injuries and other complications (NICE 2002). An economic model developed by NICE's assessment group also suggested that ultrasound guidance was

"both more effective and less costly than the landmark method."

Now the standard of care in the UK, ultrasound-guided CVC placement is also endorsed as the preferred practice by the Agency for Healthcare Research and Quality (AHRQ 2001), the CDC and in related guidelines from many medical societies, including the American Board of Internal Medicine, the American Society of Anesthesiologists, and the American College of Chest Physicians, among others.

Best Safety Practices to Prevent Hospital Infections

Healthcare-associated infections (HAI) are now the most common adverse event affecting hospitalised patients, with about 30% of those in the ICU suffering one or more HAIs, according to the World Health Organization (WHO) (n.d.). In the European Union, about 4.1 million patients fall victim to these infections annually, killing about 37,000 patients and contributing an additional 110,000 deaths each year, reported by the European Centre for Disease Prevention and Control (ECDC) (2015).

CLASBIs rank among the leading HAIs, and major initiatives to combat these dangerous infections have been launched in both Europe and the U.S. For example, the European Commission has funded the PROHIBIT (Prevention of Hospital Infections by Intervention & Training) study, in which the ICUs of 14 participating hospitals implemented a bundle of CVC safety practices, including improved hand hygiene (WHO 2015).

In the U.S. a sustained reduction (of up to 66%) in CLASBIs occurred over 18 months in 103 participating ICUs after a five-point bundle of evidence-based CVC safety practices was implemented (Pronovost 2006). Now there is a growing movement to add a sixth element to the bundle: the use of ultrasound guidance for central line placement.

Hospitals that have implemented this approach, including Cedars-Sinai Medical Center in Los Angeles, California, have seen striking reductions in CLASBIs, while White Memorial Medical Center in Los Angeles was able to achieve a rate of zero between January 2010 and August 2011 at the 353-bed hospital. The six-point bundle used consisted of these components:

1. Hand hygiene;
2. Maximal barrier precautions;
3. Chlorhexidine skin antisepsis;
4. Optimal catheter site selection;
5. Daily review of CVC line necessity, with prompt removal of unneeded lines;
6. Ultrasound-guided line placement.

Ultrasound–Guided Peripheral IV Access as an Alternative to High–Risk CVCs

Establishing vascular access is one of the most commonly performed hospital procedures, with speed and success rate particularly critical to optimal care of critically ill and unstable patients. However, failure rates of emergent peripheral intravenous (PIV) access of 10 to 40% have been reported in the literature, with the average time needed for PIV reported at 2.5 to 13 minutes, and difficult PIV access taking up to 30 minutes (Leidel 2009).

"Ultrasound-guided needle procedures can significantly enhance the safety and quality of patient care, while helping reduce costs and complications"

Difficult PIV access may occur due to such factors as obesity, history of IV drug use, chronic illness, chemotherapy or vascular pathology (Leidel 2009; Crowley 2011), and can lead to significant delays in essential treatment for seriously ill patients who need it the most. In this situation, clinicians often use CVCs as an alternative.

Ultrasound-guided PIV may prevent many unnecessary central line placements in patients with problematic IV access. In a study involving 100 emergency department (ED) patients with difficult vascular access, ultrasound-guided PIV access eliminated the need for CVC placements in 85% of cases (Au 2012). These patients were tracked for seven days, with a zero percent rate of complications.

Given that CVCs can have a complication rate of up to 15% (Feller-Klopman 2007), with estimated costs ranging as high as US$50,000 per case (Fraenkel 2000), the study's outcomes suggest that wider use of ultrasound-guided PIVs could yield substantial improvements in patient safety with a significant reduction in ED costs. Another study of ultrasound-guided PIVs in difficult-access ED patients reported a 97% success rate, compared to only 33% when traditional landmark approaches were used (Constantino 2005). The study also reported the following results for the ultrasound group:

- Faster vascular access (13 minutes with ultrasound guidance versus 30 minutes without it);
- Fewer percutaneous punctures with ultrasound guidance (1.7 versus 3.7 with landmark methods);
- Greater patient satisfaction when ultrasound was used.

Safer, More Cost–Effective Thoracentesis and Paracentesis

Ultrasound guidance may significantly reduce serious adverse events and the cost of care in patients undergoing two commonly performed needle procedures: thoracentesis (draining fluid from the chest) and paracentesis (draining fluid from the abdomen), according to a recent study (Mercaldi 2013). The study examined data from the national Premier Prospective automated hospital database, with the following results, after adjustment for possible confounding factors:

- For the 61,261 patients who underwent a thoracentesis, ultrasound guidance reduced the rate of pneumothorax by 19%. When collapsed lung occurred, this complication raised the patient's hospital cost to US$13,784, compared to $11,032 for a patient who didn't suffer a collapsed lung. In addition, the mean length of hospital stay was 7.9 days for a patient with a pneumothorax, versus 6.5 days for a patient without it.
- For the 69,859 patients who underwent a paracentesis—often a challenging procedure to perform with blind landmark methods—ultrasound guidance lowered the rate of bleeding complications, such as haemorrhage, haematoma, and haemoperitoneum, by 68%. A bleeding complication raised hospital costs to nearly US$30,000, about triple the cost for a patient without this adverse event ($9,476), and nearly doubled length of hospital stay, from a mean of 5.2 days for a patient without a bleeding complication to a mean of 9.5 days for a patient who suffered one.

Ultrasound at the bedside can also help eliminate the risks and costs of unnecessary procedures. In one study, 100 patients with suspected ascites were randomised to receive paracentesis with landmark or bedside ultrasound-assisted techniques (Nazeer 2005). In the landmark arm, 61% of the procedures were successful. In the ultrasound group paracentesis was found to be unnecessary in 25% of the patients. In patients who actually needed fluid aspiration, ultrasound-guided paracentesis was successful in 95% of cases.

Conclusion

Robust evidence from multiple studies demonstrates that ultrasound-guided needle procedures can significantly enhance the safety and quality of patient care, while helping reduce costs and complications. The reason is simple: just as radar helps airline pilots navigate safely to the right destination at night, ultrasound visualisation allows clinicians to see their anatomical target, instead of working blindly.

As we strive to improve healthcare and rein in costs, physician leaders and hospital administrators should carefully weigh the many benefits of ultrasound at the bedside for reducing the risk of medical harm from invasive procedures performed to help patients heal. Ultimately, it is the sickest patients who will benefit the most from a best-practice approach that leads to optimal outcomes. ■

Key Messages

- Evidence-based guidelines from many medical societies recommend ultrasound-guided central venous catheter (CVC) placement as an important safety practice.
- Compared to landmark techniques, ultrasound guidance can significantly reduce medical errors and costs of needle-based procedures commonly performed in critical care, including central line insertions, paracentesis and thoracentesis.
- Use of ultrasound-guided peripheral intravenous catheters may prevent the need for high-risk CVCs.
- Ultrasound at the bedside has become an increasingly valuable tool across hospital departments for a variety of applications, while sparing patients health risks associated with ionising radiation.

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LACTATE MONITORING

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Key Messages

- Lactate is a central intermediate metabolite that is usually increased because of stress.
- Of all laboratory parameters, in the spectrum of critically ill patients, lactate has the strongest relation with outcome.
- The rate of change of circulating lactate is also of prognostic importance.
- Monitoring of lactate on short timescales is both scientifically and clinically useful.
- Future trials may establish whether continuous lactate monitoring improves outcome.

The use of lactate measurements in critically ill patients has steadily increased to a level where in some cases it may be considered lactate monitoring. In this brief review we discuss the central metabolic role of lactate in animal metabolism, and address important misconceptions as well as why lactate is mainly a marker of stress and how this translates into its unique diagnostic utility in many acute conditions. Finally several interesting future perspectives in lactate monitoring are discussed.

Elucidation of Lactate Metabolism and Misconceptions about Lactate

The history of lactate measurement and lactate metabolism is a fascinating story (Kompanje et al. 2007), having important relevance for current views on lactate, as some misunderstandings persist. From the moment it was recognised that lactic acid is generated when milk sours, some of the keenest investigators studied lactate metabolism. Several Nobel prize winners, including Otto Meyerhof, Otto Warburg, Hans Krebs, Carl Cori and Gerty Cori (Voet and Voet 2011) helped elucidate lactate metabolism. Although often interchangeably used, lactic acid (HLa) and lactate (La^-) are of course different entities, but for brevity we will not address this topic. Even at extreme physiological conditions HLa is fully dissociated into H^+ and La^-. When cells produce and export H^+ and La^-, the H^+ will be partially buffered in the extracellular space.

Early in the 20th century it was recognised that glucose is a fuel used by virtually all living organisms. In the middle of the 20th century it was discovered that in animals mitochondria are able to fully oxidise carbohydrate and fat to CO_2 and thereby generate far more ATP (adenosine triphosphate) with so-called oxidative phosphorylation than is possible by conversion of glucose to pyruvate (glycolysis) alone. In the complete absence of oxygen, cells or tissues that are capable of both glycolysis and oxidative phosphorylation can only use glycolysis. When glycolysis produces pyruvate that cannot be further metabolised by mitochondria, this pyruvate must be converted into lactate in order for glycolysis to continue. This lactate must then be transported out of the cell, and can then be converted back to pyruvate and metabolised by mitochondria elsewhere in the body.

Although all oxygen-consuming tissues possess the ability to consume lactate, the liver and kidneys also possess the ability to convert this lactate back into glucose (gluconeogenesis) and export this glucose into the circulation. The Cori cycle describes the conversion of glucose to lactate by muscles, the subsequent transport of lactate to the liver, regeneration of glucose by gluconeogenesis in the liver and then transport of glucose back to the muscle. This cycle is an important example of acute whole-body metabolic interaction between two organs. The Cori cycle allows muscles to perform longer during strenuous exercise, since the liver offloads the lactate-producing muscle. This cycle comes at a metabolic 'cost', however. When glycolysis generates two ATP from a glucose molecule in the muscle, the liver must spend six ATP to regenerate glucose from lactate. Thus at the whole-body level the Cori cycle entails a loss of four ATP for each recycled glucose. In contrast to the Cori cycle, the direct reuse of lactate by the mitochondria of other cells carries no energy penalty (Voet and Voet 2011).

"Even a far higher frequency of measurement of circulating [La^-] might be informative"

A persistent misconception about lactate metabolism is that lactate production automatically implies "anaerobic glycolysis". However, in the majority of conditions lactate production occurs in the presence of sufficient oxygen and fully functioning mitochondria. This is both the case in physiology (e.g. during maximal exercise) and in pathophysiology (e.g. sepsis). A related popular misconception is that muscle ache is the result of accumulation of lactic acid. Thus lactate has long been considered a detrimental waste product, in particular since regeneration of glucose from it by the Cori cycle involves loss of ATP. But lactate is far from a waste product. Just like glucose, lactate is a fuel with an ATP yield on par with glucose upon complete oxidation. Given lactate's central metabolic role, the body can metabolise hundreds up to thousands of millimoles of lactate per day (Cole 2003). The use of the term 'clearance' in the case of lactate

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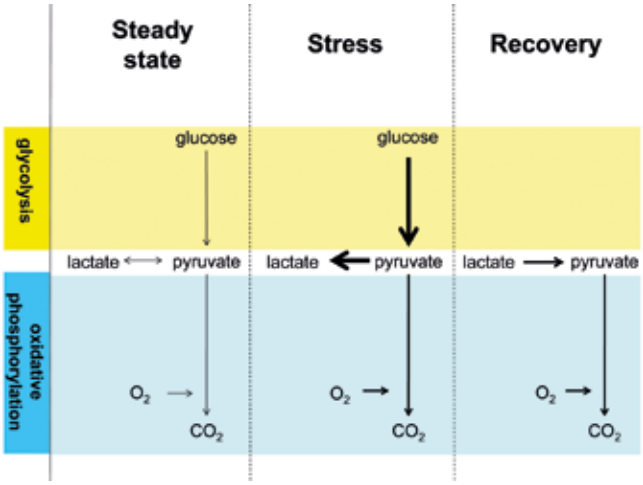

Figure 1. Three Metabolic States with Respect to Lactate Production and Consumption
Source: Adapted from Bakker 2013

In most (patho)physiological conditions, acute energy requirements are a key driver of local or systemic lactate levels, irrespective of local oxygen tension.

The *left panel* depicts non-stressed steady-state conditions where glucose is converted to pyruvate, which is subsequently fully oxidised to CO_2, generating approximately 36 ATP (adenosine tri-phosphate) per glucose molecule.

The *mid panel* depicts a stressed situation where tissue immediately requires more ATP. Glycolysis generates only 2 ATP but can very rapidly increase by a two or three orders of magnitude. Even with optimal mitochondrial oxygenation and function, this rate of pyruvate production will saturate the much more complex but much less flexible process of oxidative phosphorylation. Thus for glycolysis to continue, pyruvate must be converted to lactate.

The *right panel* depicts the post stress situation when lactate is converted back to pyruvate and fully oxidised. Since lactate can be transported both at micro and at macro scales, lactate shuttles exist that allow the simultaneous production and consumption of lactate by different cells or tissues.

is not appropriate, since its concentration is the net result of the rapidly varying production and consumption by many tissues (see Figure1).

Hyperlactataemia and Stress

Although severe hypoxia or anoxia induce lactic acidosis, the relation cannot be used in reverse, because in the majority of cases in the ICU hyperlactataemia is not caused by hypoxia but by stress. The three main conditions regarding lactate production and consumption are depicted in Figure 1. During resting steady state conditions glycolysis and oxidative phosphorylation are balanced, with no production of lactate. During stress, when increased ATP production is required, glycolysis can increase manifold. In these conditions excessive lactate production is not an indicator of tissue hypoxia, but simply reflects the ability of glycolysis to vastly outrun mitochondrial oxidative phosphorylation (Gladden 2004). The poor relation of increased [La^-] with oxygen delivery parameters underscores that stress, not hypoxia, is the common driver of hyperlactataemia (Bakker 1991).

It is well known that adrenergic β_2-activation can directly induce production of lactate (Levy 2008) and glucose. In addition, a recent study showed that hyperlactataemia and hyperglycaemia are closely associated and related to mortality in a large patient cohort (Kaukonen 2014). The well-established univariate relation of hyperglycaemia with mortality disappeared when hyperlactataemia was included. The investigators concluded that stress is the common denominator of both hyperlactataemia and hyperglycaemia (Kaukonen 2014).

In animal studies, treatment of healthy dogs with prednisone dose dependently increased blood lactate levels (Boysen et al. 2009). Furthermore a prospective controlled trial in cardiac surgery patients (Ottens 2015) showed that the synthetic glucocorticoid dexamethasone both induces hyperglyacemia and hyperlactataemia, underscoring the deep connection between both the adrenergic and the corticoid stress response and subsequent elevations of both lactate and glucose.

"Structured decision support to best interpret increased [La^-] may be of use."

Timescales on which Changes in [La^-] can Occur

In many institutions [La^-] is measured on ED admission and upon ICU admission and thereafter daily or only on indication. In other institutions all glucose measurements performed for ICU glucose-control are combined with lactate and blood gas analysis, resulting in many [La^-] values per day.

Theoretically even a far higher frequency of measurement of circulating [La^-] might be informative. The known relevant biological variation of a specific signal in relation to the accuracy of measurement determines the minimal timescales of scientific or clinical interest. In the case of [La^-] an interval of one minute makes sense, since modern detectors achieve 0.1 mmol/L accuracy and [La^-] can decrease by >0.1 mmol/L/min during recovery and increase by >1 mmol/L/min during severe stress. The rate of recovery of hyperlactataemia differs per condition. A decrease of 20% per hour suggests successful sepsis treatment (Jansen 2010), but after cardiopulmonary resuscitation or generalised seizures faster recovery rates are the rule (Vincent et al. 1983).

Monitoring of Lactate and its Clinical Utility as a Strong Marker of Outcome

It is now well-established that of all available laboratory measurements circulating lactate has the strongest univariate relation with outcome. It is quite unlikely that another routine laboratory measure will emerge that will outperform lactate in this respect. It should be noted that obviously no single laboratory value, including lactate, should serve as the sole value to interpret the condition of a patient. As transpires from its function during stress, a high [La^-] is not harmful by itself, but represents a compensatory response to a variety of severe underlying conditions (Kraut 2014). Thus [La^-] may be considered the ultimate example of a biochemical marker and not a mediator of poor outcome. The considerable clinical utility (Jansen 2009) of [La^-] rests particularly on its specificity and less on its sensitivity, as illustrated by the traffic light cartoon (see Figure 2).

A marker that highlights situations that entails increased risk can help physicians and nurses to focus their diagnostic and therapeutic resources on those who stand to benefit most. In our experience it is possible in most patients with marked hyperlactataemia to correctly identify the underlying cause. When the cause is not immediately evident, it may trigger appropriate additional investigations. The prospective randomised LACTATE trial was the first to demonstrate the benefit of [La^-] guidance during early sepsis treatment (Jansen 2010).

Whole Blood Analyser for Point-of-Care Lactate Testing

The Surviving Sepsis Campaign (SSC) has produced new recommendations titled *International Guidelines for Management of Severe Sepsis and Septic Shock: 2012*. These new updated guidelines call for lactate assays to direct therapy for septic shock. For patients with lactate greater than 4 mmol/L, SSC recommends quantitative resuscitation targeting normalization of lactate levels.

StatStrip Lactate provides a 13 second assay on a whole blood sample to allow rapid, early, goal directed therapy in septic patients. Testing is as fast and easy as bedside glucose testing. The single use StatStrip Lactate biosensor is pre-calibrated, fast and uses a very small whole blood sample (0.6 microliters) yet provides lab equivalent accuracy.

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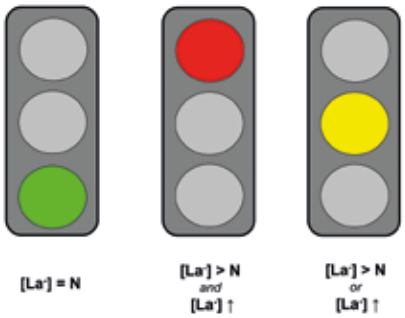

Figure 2. The Practical Importance of Lactate Monitoring

A large amount of information must be integrated (sub) consciously by intensivists when assessing ICU patients. Some parameters serve as a generic alert that something is wrong, although it may not immediately be clear what is wrong. An abnormally high [La^-] or $\Delta[La^-]$ serves as such a warning to critically assess the condition of the patient and consider alternative diagnoses and additional interventions. The red colour signifies the most alarming condition since [La^-] is elevated and still rising. Obviously, a normal [La^-] (green sign) makes severe conditions less likely, but can never exclude them.

Future Perspectives – Decision Support

We anticipate several developments concerning lactate monitoring. Continuous lactate monitoring holds great promise as suggested by first clinical studies in cardiac surgery patients with a continuous intravascular microdialysis system that allows ex vivo detection of circulating lactate and glucose levels (Schierenbeck 2014). Measuring [La^-] on timescales of minutes will likely uncover important hitherto undetected phenomena.

Continuous combined lactate and glucose monitoring may provide a powerful tool to monitor liver function, something currently not possible. When serial measurements show that [La^-] rises whilst [Glu] is 'normal' or decreases, gluconeogenesis may be impaired, indicating partial (de Felice 2014) or complete liver failure (Oldenbeuving 2014). Likewise the time course of [La^-] after an IV lactate bolus can be used to quantify the liver's metabolic ability in real time and repeatedly (Tapia et al. 2015).

Eventual incorporation of [La^-] into scoring systems that predict mortality such as APACHE or SAPS seems inevitable, since [La^-] univariately outperforms all known biochemical markers for predicting mortality. Inclusion of [La^-] is long overdue, because these scoring systems already incorporate many less powerful but equally available predictors such as potassium, leukocyte count or glucose.

An important conceptual challenge is to translate the predictive power of [La^-] and $\Delta[La^-]/\Delta t$ for specific conditions to sufficient pathophysiological understanding, so that an increased [La^-] can be optimally interpreted in individual cases. Because many different acute conditions can lead to hyperlactataemia, we believe structured decision support to best interpret increased [La^-] may be of use. Building on the principles set out in the LACTATE study (Jansen 2010), we are currently developing such a decision support system. Optimal interpretation of a rise in [La^-] within a specific clinical context may also prevent incorrect reflexes of caregivers. Unfortunately, even in our ICUs we frequently discover that a fluid bolus is administered when [La^-] rises, even if hyperlactataemia does not result from hypovolaemia, but for example from anxiety (ter Avest 2011). Designing lactate computer support will be inherently more complex than computerised glucose or potassium control, since in glucose or potassium control measurement and therapeutic corrections can to a large extent be fully 'outsourced' to the computer and the ICU nurse (Vogelzang 2008; Hoekstra 2010). The first goal for computerised lactate support should be to improve understanding of [La^-] dynamics and leave the specific diagnostic and therapeutic actions to the intensivists.

Lactate sensors employ technology very similar to glucose sensors. Thus many measurement techniques developed for glucose can be ported to lactate. Although [La^-] is currently mostly determined in critically ill patients, this measurement may also be employed in patients on general wards or even in outpatients. A potentially very important example of the latter group may be type II diabetics who usually use metformin. Metformin is a key oral antidiabetic drug used by maybe 100 million patients worldwide. A small but important minority of these patients can develop metformin associated lactic acidosis (MALA). Hand-held combined lactate and glucose measurements would be very useful for timely detection of emerging MALA in this very large population of chronic patients.

Conclusion

Lactate is a central intermediate metabolite that allows the flexible integration of the two ATP-generating systems that animals possess. Increases in lactate may usually reflect metabolic stress rather than tissue hypoxia. Increased lactate levels have a stronger relation to mortality than observed for any other biochemical marker.

The scientific and clinical rationale for more frequent measurements of [La^-] is supported by a growing body of evidence and facilitated by advanced analysers. The emerging technology of continuous lactate measurements also holds large scientific and clinical promise for critically ill patients.

We will study the impact of continuous lactate monitoring on outcome in future trials. ■

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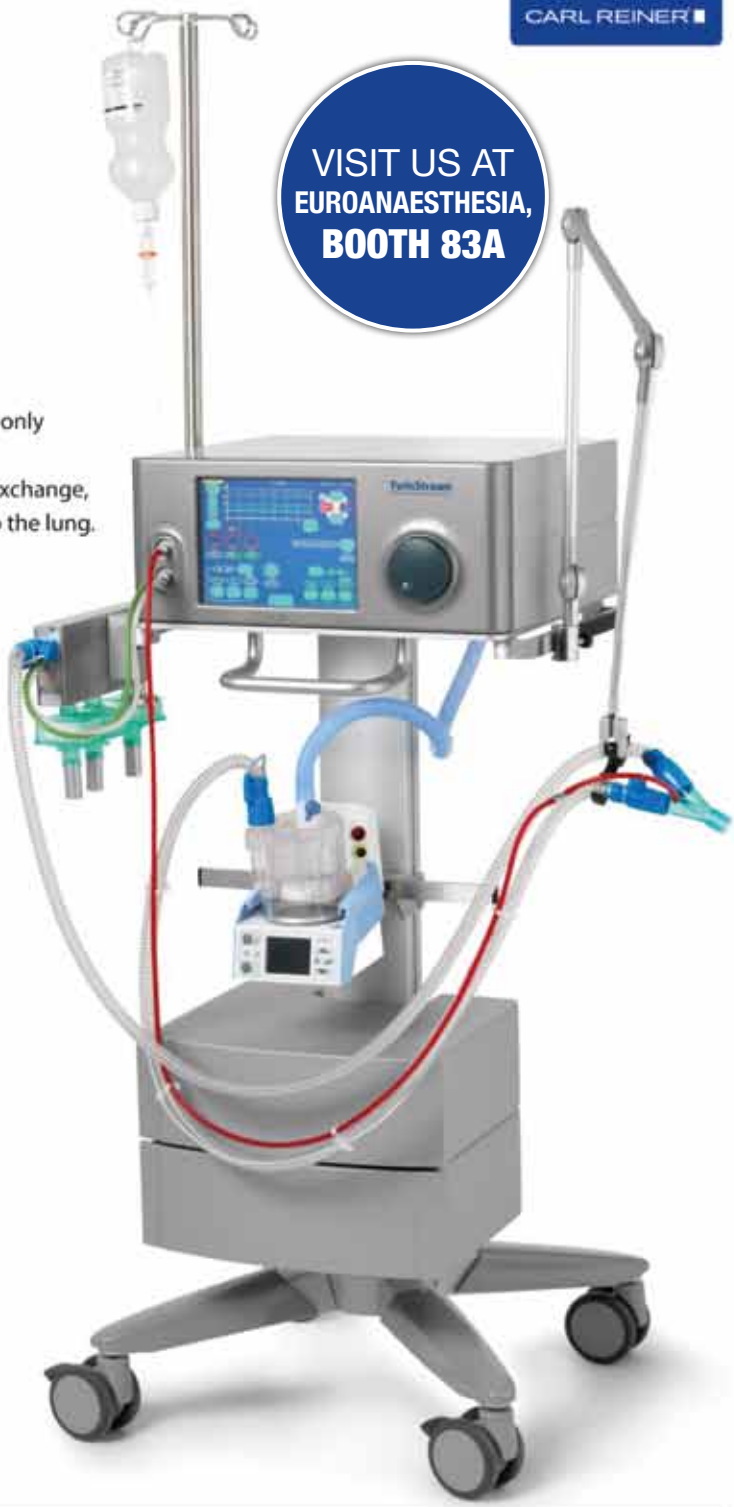

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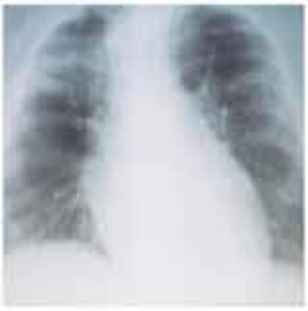

Infobox

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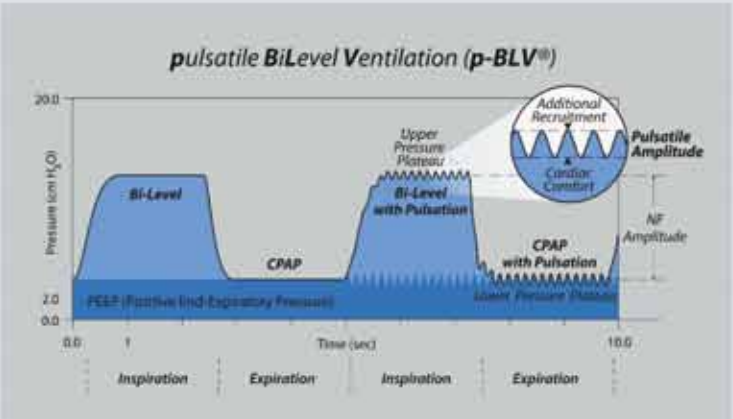

EARLY SEPSIS MANAGEMENT

Sepsis is a recognised clinical spectrum of infection that often results in catastrophic physiologic and metabolic abnormalities. This article aims to identify the derangements associated with sepsis and to review the evidence-based literature.

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The tenets of early sepsis management include diagnosis, risk stratification (elevated serum lactate or hypotension), assessment of haemodynamic response after a fluid challenge, antibiotics, source control and haemodynamic optimisation. Whether this combination of interventions is called early goal-directed therapy (EGDT), the resuscitation bundle (RB) or a standard operating procedure (SOP), mortality is improved when performed. Figure 1 (EGDT algorithm) on p.70 delineates how to carry out EGDT in the management of sepsis. We will discuss these treatments in the paragraphs to follow.

The incidence of sepsis is rising as patients who are at high risk are living longer with multiple co-morbidities. As a result hospitalisation for the diagnosis of sepsis is increasingly more common. Sepsis-associated mortality ranges from 15-49% (Angus et al. 2001), and contributes to nearly 17-40% of hospital deaths, making it the most lethal hospital admission diagnosis (Kumar et al. 2011). As the population continues to age, sepsis-related admissions are projected to continue to rise, making standardised approaches to the identification and treatment of sepsis imperative.

Early Detection or Screening for Sepsis

The systemic inflammatory response syndrome (SIRS) was developed as a clinical aid to direct the clinician to entertain the diagnosis of infection. It comprises two of the following four items: 1) temperature >38.3°C or <36.0°C; 2) heart rate >90 beats/min; 3) respiration rate >20 breaths/min or 4) white blood cell count >12,000 or <4000/mm^3 , or >10% increased bands or immature cells (Bone 1985; Rangel-Frausto et al. 1995). The first use of SIRS for screening revealed that the more SIRS criteria, the greater degree of admission, increased length of hospital stay and costs (Tuttle 1996).

Antibiotic Therapy

The evidence for cultures and early and appropriate antibiotic administration is abundantly present in both animal and human studies of sepsis (Natanson et al. 1990). Bacteraemia is associated with an increased mortality, and this mortality may be increased up to five-fold in patients who receive inappropriate initial antibiotic therapy (Kang et al. 2012; Cardoso et al. 2010; Levy et al. 2010; Kumar et al. 2009). Mortality can increase up to 7.6% for each hour delay in antibiotic administration after the onset of hypotension or shock (Kumar et al. 2006; Ferrer et al. 2014).

Source Control

Source control is imperative and should be done as quickly as possible following initial resuscitation. The tenets of source control are appropriate radiographic imaging and interpretation, removal of the insult or a definitive surgical procedure. Every hour of delay from admission to surgery has been associated with an adjusted 2.4% decreased probability of survival or a 16% reduction in mortality if no source control within 6 hours (Bloos et al. 2014; Marshall and al Naqbi 2009; Buck et al. 2013). Patients who had surgical source control delayed for more than 6 hours had a significantly higher 28-day mortality (42.9% vs. 26.7%, $p < 0.001$); this delay was independently associated with an increased risk of death (Bloos et al. 2014; Dellinger et al. 2013b).

Risk Stratification (Lactate and Refractory Hypotension)

A hypotensive episode (systolic blood pressure less than 90 mmHg) is associated with an increased risk for death whether in the ED or inpatient unit (Jones et al. 2006; Lee et al. 2014). The discriminatory value of hypotension increases after a fluid challenge (Lee et al. 2014). If hypotension is not corrected by a fluid challenge, this portends early organ dysfunction, haemodynamic decompensation and increased mortality (Lee et al. 2014; Liu et al. 2013; Khalid et al. 2014). Ironically, paradoxical hypotension can be seen after fluid challenge (Lee et al. 2014b). Hypotensive ward patients who deteriorate further after initial stabilisation have a higher mortality (up to 42%, 28-day) and increased hospital resource consumption (Champunot et al. 2014; Khalid et al. 2014; McKinley et al. 2011). Hypotension refractory to fluids and requiring vasopressor therapy carries a mortality of 20 to 52% (Levy et al. 2010; Cannon et al. 2010; Durairaj and Schmidt 2008; Hilton and Bellomo 2012; Lee et al. 2012).

Weil and Aduen et al. established the prognostic value of a lactate greater than or equal

to 4mM/L on hospital admission, which has been confirmed by multiple studies (Broder and Weil 1964; Cady et al. 1973; Aduen et al. 1994; Mikkelsen et al. 2009; Trzeciak et al. 2007; Shapiro et al. 2005; Pearse 2009). Whether central venous or arterial (Reminiac et al. 2012), increased lactate levels are associated with increased mortality (Puskarich et al. 2014; Howell et al. 2007). Clinical deterioration in patients with intermediate lactate levels (between 2.0 and 4.0 mmol/L) means that they are particularly at risk for mortality, as 22.7% will progress to sepsis-induced tissue hypoperfusion with an associated mortality of 10.1% (Hoon et al. 2012).

Lactate levels can be normal in septic shock and should be used with caution as a sole screening tool and endpoint (Singer et al. 2014; Dugas et al. 2012; Wacharasint et al. 2012; Cannon et al. 2013; Song et al. 2012). Blood lactate levels are not uniformly elevated in critically ill patients with liver disease, and levels above 2.2 mM/L are associated with increased mortality (Kruse et al. 1987). A normal shock index (heart rate/systolic blood pressure (<0.7) in patients presenting with a presumed infection indicates very low risk (high negative predictive value) for increased lactate levels (>4 mM/L) (Berger et al. 2013; Rady et al. 1994; Rady et al. 1996).

The Pathobiology of Haemodynamic Optimisation

Sepsis is a result of severe haemodynamic triggers that ultimately result in an imbalance between oxygen supply and demand. Based on this principle, EGDT sought to identify these abnormalities and aim for early correction and restoration of homeostasis. In light of a trilogy of recent publications comprising Protocolized Care for Early Septic Shock (ProCESS) (ProCESS Investigators et al. 2014), Australasian Resuscitation in Sepsis Evaluation (ARISE) (ARISE Investigators et al. 2014) and Protocolized Management in Sepsis (ProMISe) trials (Mouncey et al. 2015), this article aims to highlight the best practice recommendations for early sepsis management.

Preload Optimisation or Intravenous Fluids

Due to physiologic fluid shifts and fluid losses, septic patients are often volume depleted, and a minimum of 20-30ml/kg of fluid should be given. Following this initial bolus, infusion of intravenous fluids may be continued as long as the patient continues to improve haemodynamically. In regards to choice of fluid therapy, studies have shown that resuscitation with crystalloids, such as normal saline or lactated Ringer's or albumin, does not confer a reduced mortality in severe sepsis but may in septic shock (Rochwerg et al. 2014; Delaney et al. 2011). Albumin may be a considerable adjunct when patients require large amounts of crystalloid infusion (Caironi et al. 2014).

One of the benefits of aggressive fluid therapy is a reduction in vasopressor use during the first 6 hours. Early reduction in vasopressor therapy further reduces the need for vasopressin and corticosteroid use and may confer improved mortality (Waechter et al. 2014).

Preload Measurement (Central Venous Pressure or Other Surrogates)

A central venous pressure (CVP) of between eight and 12 mmHg is recommended to mitigate the circulatory insufficiency in the form of hypovolaemia and loss of vasomotor tone. Recent studies have called into question the value and necessity of CVP monitoring, due to inability to find a reliable relationship between blood volume and recorded CVP (Schmidt 2010; Marik and Cavallazzi 2013). Clinically the picture is often more complex than an isolated number, as coexisting conditions such as anaemia, myocardial suppression, mechanical ventilation, arrhythmias and vasopressor administration can

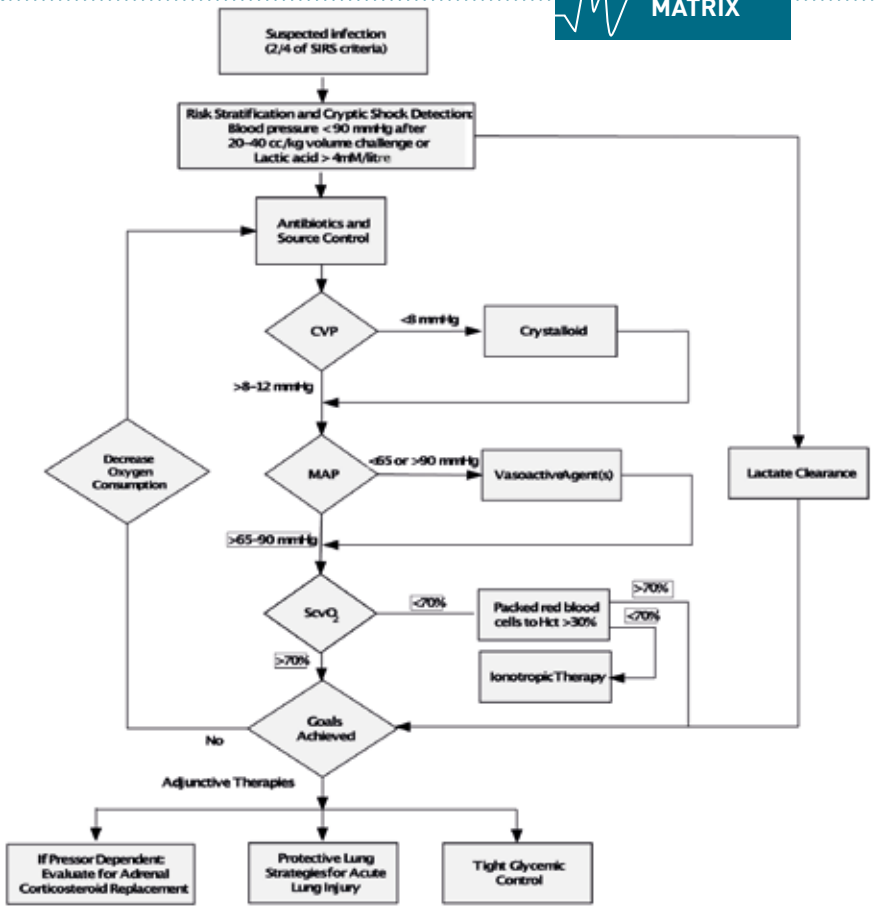

Figure 1. Algorithm of Early Goal-Directed Therapy with Recommended Ancillary Treatments

play a role in falsely elevated or depressed values. CVP-guided fluid administration has been shown to decrease vasopressor therapy and in the early stages of sepsis has been shown to decrease mortality (Walkey 2013). On the contrary, aggressive fluid resuscitation in the late stages of the sepsis spectrum has been shown to increase morbidity, mortality and ventilator-dependent days (Murphy et al. 2009). In patients in whom central line placement is difficult or undesirable, bedside echocardiography, inferior vena cava measurements for respiratory variation, transoesophageal Doppler monitoring and stroke volume variation using arterial pulsation monitoring can be alternatives. However, clinical pitfalls exist with these modalities as well, and the clinical picture on the whole should be given greater weight than an isolated lab or mechanical value.

Afterload (Blood Pressure Target and Vasopressor Use)

Sepsis-associated vasodilatation and the loss of systemic autoregulation often necessitate administration of vasopressors (Dellinger et al. 2013a). Studies have shown that delays in restoration of physiologic blood pressure are related to increased mortality risk (Dunser et al. 2009; Beck et al. 2014). While increasing mean arterial pressure (MAP) above 65 mmHg has been associated with increased cardiac output, improved microvascular function and decreased blood lactate concentrations, there is substantial individual variation (Thooft et al. 2011). An individual's physiologic baseline and personal needs should be contemplated on a case-by-case basis; however, the recommended target mean arterial blood pressure is 65 mmHg (Varpula et al. 2005; Dunser et al. 2009; Asfar et al. 2014). Levy et al. have shown that the delayed use of vasopressor therapy for cardiovascular support is incrementally associated with a significantly higher mortality than any other organ failure beyond the first 24 hours (Levy et al. 2005).

There has been no demonstrable difference in the rate of death between patients treated with dopamine as the first-line vasopressor agent or norepinephrine; however, the use of dopamine has been associated with a greater number of adverse events (De Backer et al. 2010). Although studies have not shown outcome improvements with low-dose vasopressin, there is evidence that concomitant corticosteroid therapy may be beneficial (Russell et al. 2009; Gordon et al. 2014).

Initiation of vasopressor therapy should be done with caution, as it may be detrimental. Early initiation can falsely elevate CVP if started immediately after central venous line placement and prior to complete fluid resuscitation (Nouira et al. 2005). Thus the focus during the first hour should be aggressive fluid administration, only thereafter starting vasoactive agents, while continuing aggressive fluid administration (Waechter et al. 2014).

Central Venous Oxygenation

Central venous oxygenation (ScvO2) has the unique ability to demonstrate imbalances between oxygen delivery and oxygen consumption, and studies have repeatedly proven the utility and outcome benefit of this endpoint (Chamberlain et al. 2011). For instance, it has been shown that early ScvO2 can predict the difference between sepsis survivors and non-survivors and outcomes in acute lung injury after nearly 47 hours (Varpula et al. 2005). EGDT calls for action manoeuvres based on persistently low ScvO2 on the basis that therapies are necessary to either increase oxygen delivery or decrease venous oxygen consumption to prevent or limit tissue hypoxia, lactate generation and cardiopulmonary complications. Suggested goals for increasing ScvO2 involve fluid resuscitation, inotropic administration, red blood cell transfusion and decreasing systemic oxygen demands (early intubation). Although the trilogy of recent sepsis trials confer no mortality benefit of ScvO2 over usual care, recent studies show increased mortality and outcome benefits when ScvO2 is corrected (Boulain 2014; Levy et al. 2014).

Arterial Oxygen Content (Oxygen and Blood Transfusion)

Anaemia in sepsis is associated with an increase in both myocardial and systemic oxygen extraction rates accompanied by a compensatory increase in cardiac output. Anaemia can be multifactorial, and the underlying causation ranges from the dilutional effect of aggressive fluid resuscitation, bone marrow suppression, disseminated intravascular coagulation and the presence of pre-existing illness. Ultimately, the increase in myocardial oxygen consumption can lead to troponin elevations, increasing lactate levels, tachyarrhythmias and persistent hypotension. Targeting a pre-established 'optimal number' can be complicated as haemoglobin concentrations and requirements vary by organ, circulation and co-morbidities. Prior transfusion-related studies have shown inconsistent data, with a recent study showing no significant difference in 90-day mortality, use of life support or ventilator-free days when a level of seven g/dL versus nine g/dL was targeted (Holst et al. 2014). Current recommendations aim to limit transfusions to patients with persistently low ScvO2 despite appropriate interventions based on the patient's clinical picture, including vital signs and known pre-existing conditions (cardiovascular disease).

Myocardial Dysfunction

Suspicion of myocardial dysfunction should be raised in patients with persistently low ScvO2, elevated CVP and lactate level. This can be present in up to 15% of patients of patients in septic shock (Jozwiak et al. 2011). Bedside ultrasound may demonstrate depressed ejection fraction and decreased cardiac motility. Dobutamine is the first-line inotropic therapy due to its ability to increase cardiac output by increasing cardiac contractility and heart rate. While its use in sepsis has not been shown to improve mortality, a trial of dobutamine up to 20μg/kg/min carries a 1C recommendation by the Surviving Sepsis Campaign guidelines.

Decreasing Systemic Oxygen Demands

Increased metabolic demands, which cannot be met by increasing systemic oxygen delivery, can contribute to ongoing tissue hypoxia. Fever and increased work of breathing can account for up to 40% of oxygen consumption in sepsis and animal studies have shown mechanical ventilation to mitigate the early effects of sepsis on haemodynamics (Correa et al. 2012; Manthous et al. 1995; Beisel 1980). Initial mechanical ventilation should be approached with caution as it can decrease venous return, and the medications used for rapid sequence intubation are associated with blunting of the sympathetic drive and arterial and venous dilation. If aggressive fluid resuscitation has yet to be undertaken, the patient can become rapidly hypotensive following intubation. When these precautions are considered and mitigated, early paralysis in patients with acute lung injury has been associated with improved outcomes.

Conclusion

A recent trilogy of studies (PROCESS, ARISE and ProMISe) sought to examine EGDT as a haemodynamic optimisation study, particularly the need for CVP and ScvO2 monitoring during resuscitation (see Tables 1-3). These studies provided early diagnosis, risk stratification (elevated serum lactate or hypotension), assessment of haemodynamic response after a fluid challenge, antibiotics, source control and early ICU admission to all groups with unblinded care in all treatment groups. This trilogy found no difference between EGDT and usual care as provided in these trials. Because of providing many components of EGDT in all treatment groups, mortality from sepsis has been reported at all time lows by all of these trials. The question remains whether an invasive or noninvasive method (with or without CVP) confers improved mortality. It must be remembered that EGDT provided no harm consistent with proven benefit in over 45 publications comprising over 40,000 patients with equal mortality benefit as the original trial (Wira 2014; Jones 2008; Barochia 2010; Wang 2012; Gu 2014). While these controversies continue to be discussed, we do know that patients with sepsis need early intervention and benefit from parameters to measure response to resuscitation. ■

For full references, please email **editorial@icu-management.org**, visit **www.icu-management.org** or use the **article QR code**.

	EGDT (Rivers et al. 2001)	ProCESS (ProCESS Investigators et al. 2014)	ARISE (ARISE Investigators et al. 2014)	ProMISe (Mouncey et al. 2015)
Location	United States	United States	Multi-centre, multinational	England
Average number of Patients enrolled per month/centre	7	0.7	0.5	31.5
Lactate screening	None	Required	Required	Required
Existing sepsis protocols (SSC 2004, 2008, and 2012)	No	Yes, (SSC and individual centres)	Yes	
(SSC and national standards)	No			
Care provided (blinded)	ED unblinded			
ICU was blinded	ED/ICU unblinded	ED/ICU unblinded	ED/ICU unblinded	

Table 1. Study Comparison

ARISE, Australasian Resuscitation in Sepsis Evaluation; ED, emergency department; EGDT, early goal-directed therapy; ICU, intensive care unit; ProCESS, Protocolized Care for Early Septic Shock; SSC, Surviving Sepsis Campaign

	EGDT EGDT	Control	ARISE EGDT	PBST	UC	ARISE EGDT	UC	ProMISe EGDT	UC
Fluids prior ENR, mL			2,254	2,226	2,083				
Total fluids 0-72 hours mL			7,720	8,175	6,663	6,906	6,672	5,153	5,194
VP at enrolment, %			19.1	16.8	15.1	21			
VP 0-72 hours, %	36.8	51.3	27.3	24.0	22.4			681	608
Any inotrope, %	15.4	9.2	9.3	2.5	2.9			220	63
PRBC 0-6 hours, %	64.1	18.5	14.4	8.3	7.5	13.6	7.0	55	24
Any PRBC, %	68.4	44.5	9.3	2.5	2.9			131	74

Table 2. Interventions

ARISE, Australasian Resuscitation in Sepsis Evaluation; EGDT, early goal-directed therapy; PBST, Protocol-Based Standard Therapy; PRBC, Packed Red Blood Cell; ProCESS, Protocolized Care for Early Septic Shock; UC, Usual Care; VP, Vasopressor

	EGDT EGDT	Control	ProCESS EGDT	PBST	UC	ARISE EGDT	UC	ProMISe EGDT	UC
Predicted mortality based on APACHE II, %	40.3	36.9	38.2	37.5	37.9	21.0	21.0	32.2	29.1
Observed hospital mortality, %	30.5	46.4	21.0	18.2	18.9	14.5	15.7	25.6	24.6
60-day mortality, %	44.3	56.9	21.0	18.2	18.9				
90-day mortality, %			31.9	30.8	33.7	18.6	18.8	29.5	29.2
Duration hospital stay, days	13.2	13.0	11.1	12.3	11.3	8.2	8.5	9	9

Table 3. Outcomes

APACHE II, Acute Physiology and Chronic Health Evaluation II; ARISE, Australasian Resuscitation in Sepsis Evaluation; EGDT, early goal-directed therapy; PBST, Protocol-Based Standard Therapy; ProCESS, Protocolized Care for Early Septic Shock; UC, Usual Care

RAPID PATHOGEN TESTING WITH PCR/ESI-MS

The RADICAL multicentre observational study was performed to compare PCR/ESI-MS to standard microbiology in critically ill patients.

Dr. David Brealey, Consultant Intensivist at University College Hospital, London, was one of the investigators in the UK arm of this trial, and explains more about the challenges of diagnosing infections in the ICU and the potential of rapid pathogen testing PCR/ESI-MS.

What are the key challenges in the diagnosis of severe infections and sepsis?

The clinical definition of sepsis is extremely vague, and many conditions can masquerade as "sepsis". Doctors are often unable to determine when a patient's current temperature or condition is related to an infection or some other process. They worry that they may miss an infection or a septic episode, and therefore treat the patients with antibiotics. What is unclear with the current definition of sepsis is how many of those patients treated with antibiotics do not actually have an infection, let alone sepsis. The pressure on clinicians is not to miss sepsis and to prescribe antibiotics in what is described as a "timely manner". There are many patients getting antibiotics, who perhaps don't need them. That exposes them to a degree of risk, and in the hospital environment the more powerful broad-spectrum antibiotics can have a significant impact on vital organ function. From the society point of view the broad-spectrum antibiotics drive multi-drug-resistant bacteria. The issue, put simply, is overuse of antibiotics by doctors, who are unsure whether the patient is truly infected or septic, because sepsis definitions are so poor and diagnostic techniques are inadequate.

Are the current methods used for the diagnosis of sepsis adequate? If not, why not?

Currently the diagnosis of sepsis is clinical, and it is backed up by blood or sputum cultures. If you treat bacterial cultures inappropriately, those bacteria are not going to thrive and divide and we are not going to detect them. Giving patients antibiotics before the cultures are taken really lowers your chance of getting any results through. At our institution and others, in the critical care environment only about 10% of blood cultures ever show a positive result. Assuming that most doctors take a blood culture because they think the patient might just be septic, only 10% come back as positive, and it takes about 48 hours for the results. 48 hours to wait for a result for someone who might actually be septic is just too long. We need to have antibiotics administered within the hour. If you compare sepsis as a medical emergency to stroke, the diagnostic process is lacking. If someone comes into hospital anywhere in Europe with a stroke, they will be rushed to a stroke centre, have a CT scan, and an immediate diagnosis and treatment will be given. What they won't do is give you a very dangerous treatment now, not really knowing whether or not you have the condition. Diagnostics for sepsis is far behind diagnostics for other medical emergencies.

You were part of the RADICAL Study, can you briefly tell us about the main findings?

The RADICAL study was a comparison of the rapid pathogen detection technology, PCR/ESI-MS, versus standard hospital i.e. culture techniques. The study compared this in a real world environment. If you were in a RADICAL centre, and the doctor was taking a blood culture or a culture from any other part of your body because they thought you were septic, they would also take a sample for PCR/ESI-MS. The two were directly compared.

The key finding is that PCR-ESI-MS was able to identify over three times the number of pathogens in blood compared to culture, and in about 8 hours compared to 48 hours. The hit rate for cultures was about 11%. Eleven percent of cultures found something, whereas PCR/ESI-MS found about 33%. The other startling finding was the negative predictive value, such that if PCR/ESI-MS was unable to find something in 8 hours, you could be 97 percent sure that your cultures were also going to be negative at 72 hours. This gives you early on the confidence that probably there is no bacteria, fungus or virus there. That doesn't mean there is no infection in the body, because you can have a localized infection that doesn't go into the bloodstream. It may not give you the confidence to stop antibiotics, but it certainly could lend some weight in that direction. We also looked at cultures from the respiratory tract, bronchoalveaoli, which are difficult to look at, as they are colonized with a lot of different bacteria, and PCR/ESI-MS outperformed culture there and in a fraction of the time.

It was an observational trial, so we were just looking at what the results were, we were not acting on them, and the clinicians didn't know the PCR/ESI-MS results. The trial didn't answer what would change if the results were known, so we asked a pool of independent doctors to look at the results and the clinical case reports, and asked if they would change the way they managed the patient. 42% stated that they would have altered the patient's management. If the PCR/ESI-MS result was positive, that went up to about 53%. Mostly they would have reduced the number of antibiotics, and leading on from that, the side effects and the exposure and pressure of multi-drug resistance, resulting in the de-escalation of antibiotics in the hospital environment. The question of what would really happen if the clinician had the result is unanswered at the moment, and trials are being designed to discover that.

In which way do you think PCR/ESI-MS could improve antibiotic stewardship in the ICU?

The technology on its own in a lab won't make a difference. But combined with active reporting and active stewardship it could make a massive difference. The patient comes into the ED, and you think they have pneumonia – within 6-8 hours, with PCR/ESI-MS you would know if they have bacteria in their bloodstream. I would suggest what's needed is that as the result comes out so a microbiologist phones to advise on what antibiotics are needed. In hospitals it's usually the residents who prescribe

antibiotics and they won't necessarily have the confidence to de-escalate antibiotics. So the speedy result need to be backed up with good stewardship and excellent communication.

What in your opinion will be the main barriers for adoption of PCR/ESI-MS?

The main barrier to hospital administrators will be cost, and obviously the business case has to be made alongside the evidence for its effectiveness. If you can prove that this technology makes a difference, reduces mortality, time on intensive care or hospital length of stay, antibiotic usage and therefore the drugs budget, that is the financial business case. The evidence for this needs to be amassed.

The other barrier is culture. Doctors need to be weaned off antibiotics as a crutch for any unknown fever. We need the diagnostics to be sure that stopping antibiotics, or not starting them in the first place is the right thing to do. The RADICAL study is a good start. We have to get that culture change going.

Can you describe for us a clinical situation where you think PCR-ESI-MS could be useful?

UCL has patients undergoing bone marrow transplants for haematological malignancies such as leukaemia. The problem is that they are immuno-suppressed. They almost invariably get a temperature after transplants, and because we cannot diagnose it immediately, they all get antibiotics. Some get better, but some persist and come to intensive care. By this point they are saturated in antibiotics, and you are unable to tell if the kidney or liver failure is the result of drug reactions or the bone marrow transplant or an infection or something else. Cultures will all be negative because the patient is saturated in antibiotics. Knowing what we are dealing with will mean cutting antibiotics out and targeting the ones we need to.

PCR/ESI-MS could make a difference when it is an emergency and inappropriate to wait 48 hours for a result. It could revolutionize the way we handle sepsis, in a way we haven't seen for decades. ■

Note

The technology (PCR/ESI-MS) evaluated in the RADICAL study is now commercially available as the CE-marked IRIDICA platform and assays.

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DISCLOSURE:
"Point-of-View" articles are part of the ICU Management Corporate Engagement Programme

WHY IS DRUG TRACEABILITY IMPORTANT IN A HOSPITAL?

IMPLEMENTATION AT HOSPITAL ALEMÁN IN ARGENTINA

The acute condition of hospital patients and the use of higher risk medication increases the consequences that counterfeit and illegitimate pharmaceutical products can have on them. Delivering the right and genuine product to the right patient is crucial.

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In our globalised economy, the risks of harming the patient can stem from counterfeited medicines. It is not easy to know the counterfeit drug rate globally, because there is significant variation across countries, but it affects both developed and developing countries. The higher rates are in developing countries, and drugs that treat serious diseases such as malaria, tuberculosis, AIDS or other infections are more often the object of counterfeiting.

The most common factors leading to the occurrence of counterfeit drugs are the lack of legislation, weak national drug regulatory authorities, erratic supply of drugs, lack of control of drugs for export and import, free trade zones, corruption and conflict of interest (World Health Organization 1999).

Counterfeit drugs have rarely been efficacious, and in most cases they have been dangerous (Amon 2008; Kelisides et al. 2007; Tomić et al. 2010). The right compounding of medicines and supervision of the supply chain is a must. We must ensure the availability of a safe and efficacious drugs supply.

Benefits of Traceability

As of 1 June 2012 new regulations on the traceability of medicines in Argentina require a specific identification to be placed on a large group of pharmaceutical products. This new regulation implements effective countermeasures against counterfeit and substandard drugs.

Traceability is the ability to track specified stages of the supply chain and trace backwards the history, application or location of the pharmaceutical products that are under consideration. The global standardised identification system from manufacturer to patient provides a safer healthcare supply chain. The data within the GS1 (www.gs1.org) barcodes now enables automatic identification of the products at any point in the supply chain.

This secure system will identify products with the GS1 Standards using data carriers like Data Matrix, RFID or barcoding systems with the "traditional" linear barcode data carriers.

The traceability process is for the pharmaceutical industry also a way to an eventual effective and fast product recall of specific batches or lots of medicines from the market. These could be achieved in a relatively short time to avoid medication errors. Traceability gives also the possibility of a quick inventory. It is a challenge to analyse all the supply chain inefficiencies.

Traceability Implementation at Hospital Alemán

It is important that the external packaging of pharmaceutical products undergoes further control and security, thinking of the global pharmaceutical supply chains. This identification of each packaging of medicines such as the Global Trade Item Number or GTIN and some dynamic and variable data like unique serial number, batch/lot number and expiry date makes each packaging unique. This identification is now our regulatory and legal requirement in Argentina.

Hospital Alemán is a university hospital located in Buenos Aires, Argentina, with more than 700 doctors providing care in all specialties. The hospital has 240 beds in individual rooms, 11 operating theatres, a coronary unit, adult and paediatric intensive care units, burn area care and a transplant centre.

The barcode of the secondary packaging is just the beginning of the procedure in our hospital. During the traceability process the hospital pharmacy needed to ensure that they could accept and store the medicines in line with GS1 Standards (www.gs1.org/healthcare/standards).

The end-to-end point-of-dispensing coding involves three specific steps in our hospital:

1. Hospital reception of traceable drugs;
2. Single dose fractioning at the inpatient pharmacy with the GTIN (static data) and the dynamic data of the drug in each unit dose;
3. Administration to the patient after nurses have scanned the barcode symbol.

All our suppliers were audited as a part of a quality assurance programme, which ensures that products are produced and controlled according to the quality standards appropriate to their intended use and as required by the marketing authorisation and product license (Good Manufacturing Practices).

The suppliers must provide the barcode of the secondary packaging as a proper identification of their pharmaceutical products in accordance with the national regulations.

At the hospital reception the internal digitising of the supply chain with increased efficiency begins. Each item of packaging is checked against a database and the information is sent to a division of our Health Ministry, the ANMAT, ensuring that the patient received a genuine drug. The ANMAT exercises duties in inspection, oversight and control over food, medications, and medical devices in Argentina.

They manage the National Traceability System for Pharmaceutical Products to the GS1 Standard.

The scan reveals if there is any duplication of data on the packaging. In this case, the ANMAT System sends the pharmacy an immediate alert about the possibility of a fake medicine.

Before dispensing to a patient in the inpatient ward, the traceable drug is fractioned in unit doses at the pharmacy. This is a huge task. A significant amount of time and effort has been spent to ensure full compliance with GS1 Standards. The medicines are re-labelled using a printed GS1-Data Matrix linking to the original information from the pharmaceutical packs.

We re-packaged the unit doses in an aseptic laboratory. A programme of maintenance is implemented in order to control the machine, the printers and the labels. All this work is carried out under the close surveillance of a pharmacist (Cina et al. 2006; American Society of Health-System Pharmacists 2011).

How it Works in the Inpatient Ward

The main objective is to achieve the five well-known rights:

- Right patient,
- Right drug,
- Right route,
- Right time, and
- Right dose.

Providing safe healthcare depends on highly trained individuals with responsibilities, who are acting together in the best interests of the patient.

Standardising internal processes was essential. The Traceability Manual was drafted. All multi-task personnel were trained, focused towards a continued improvement.

The doctors in our hospital prescribe in the electronic medical history. The pharmacy dispenses the medication and the nurse scans the unit dose of the original packs before administration to the patient happens. This is one of the critical stages of the medical treatment. Scanning allows confirmation that the right product is supplied to the right patient with an online verification of batch and expiry date. The information is stored in the database of ANMAT and the dispensing of each unit to a patient can be recorded in our electronic system.

The patient data remains confidential (except to the hospital pharmacist) during the entire process.

"A traceability system increases the protection of patients"

Outpatients

Whenever a patient comes to our official pharmacy, the pharmacist will scan the GS1 Data Matrix at the point of dispensing, and scan the GS1 Data Matrix on the medicine's packaging. It is much easier because the patient receives the complete and original pack of his medicine and we only have to scan the original Data Matrix on the secondary medicines packaging. We link the prescribed patient's medicine to the dispensed medicine.

Conclusion

To continue improving the traceability process in the hospital it is essential:

- To train the personnel constantly, keeping a great collaboration between all members of the multitask team.
- To focus towards continuous improvement, in order to create confidence in the patients, personnel and management that the drug administered fulfills the specified quality requirements.

There is growing concern regarding counterfeit medications. Drug quality is currently receiving renewed global attention. The appearance of counterfeit pharmaceutical products in supply chains is an international public health problem that may seriously affect the security of patients. According to the World Health Organization (WHO) definition, counterfeit drugs may be generic or innovative. They do not meet quality standards and do not declare their real composition and/or source for the purposes of fraud. They may contain genuine constituents in a fake packaging, or wrong ingredients, or inactive ingredients or an incorrect quantity of the active substance.

The execution of a traceability system increases the protection of patients from falsified, expired or recalled medicine. This system generates an environment of greater safety and allows medicine confidence for the patients, the medical professionals and the management of the Hospital Alemán. Consequently it is to be hoped that criminal activities derived from the trade of illegal medications will dramatically drop in the future. ■

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MOVING FROM "LEARNING BY DOING" TO SIMULATION

THE EDUCATIONAL CHALLENGE IN ANAESTHESIA AND INTENSIVE CARE

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Historically, medical education has focused on the autonomy of healthcare providers, who are expected to take care for a patient on their own. Consequently, issues related to teamwork, multidisciplinary and multi-professional interactions have not been explicitly and formally included in medical curricula. In addition, the hierarchical organisation of medicine, mainly expressed by a communication philosophy following a chain of command, has strongly contributed to discouraging teamwork-based patient care.

Healthcare providers are mainly trained as individuals, yet work almost exclusively as teams, showing a big difference between education and reality. Poor communication has been identified as the primary root cause in more than 70% of perinatal sentinel events recorded by the Joint Commission on Accreditation of Health Care Organizations (2004) that suggested simulation training as an effective way to improve teamwork as one of the means to improve patient safety (Kohn et al. 2000). Stress, poor communication, failure to identify and correct errors, and the culture of blame, often lead to undesired outcomes in patients' care.

Evidence is increasing that traditional approaches to anaesthesia and intensive care training are no longer acceptable in the current ethical and professional context.

Alternatives to "learning by doing" in a clinical context are currently available from recent developments in simulation and virtual reality.

Simulation, which includes scenarios or environments designed to closely resemble real-world situations, offers a safe environment within which learners can repeatedly practise a range of clinical skills without endangering patients. Simulation techniques have been used to teach all aspects of medical care, including knowledge, technical and non-technical skills. In addition, simulation teaching has been identified as the optimal instrument to control human factors and prevent medical errors.

Simulation is now widespread in many fields of human endeavour and its history stretches back over centuries. The modern aviation industry has developed high-fidelity flight simulation and has led on improving the non-technical skills of teams through crew resource management programmes. Crew Resource Management (CRM) and Human Factors (HF) are acronyms used by airlines designed for safety training and educational systems for high-risk industries. The basic concept and mission of these training programmes are to reduce mistakes or errors, resulting in safer and more efficient workplaces from fewer incidents and accidents.

Anaesthesiology was one of the first medical specialties to demonstrate the impact of human factors. Indeed, in the early 1990s, David Gaba and colleagues, at Stanford University, designed a mannequin-based simulator to systematically tackle such challenges during anaesthesia crisis situations (Gaba et al. 2001). This group, led by David Gaba, developed the concept of anaesthesia crisis resource management (ACRM), which addressed human factors in the operating room setting (Gaba et al. 2001). Since then, several centres around the world have implemented simulation-based crisis resource management training. As the concept extended into different domains and specialties, it was called crew resource management (CRM) (Reader et al. 2006).

Communication, teamwork, decision making and situation awareness, in addition to medical knowledge and practical skills, have been well defined in medical literature as categories of competencies that are necessary for a team to operate effectively. Medical teachers should be aware of two main types of skills: technical (psychomotor) and non-technical (Reader et al. 2006); the latter includes significant skills that deserve specific mention like decision-making, flexibility, assertiveness, mutual respect, identifying priorities, situational awareness and fixation errors management. All these skills can be effectively thought through and practised by simulation. Overwhelming compelling evidence highlights the importance of simulation-based training as a method to improve teamwork for patients' safety.

Centre for Simulation, Hospital A. Gemelli

The Teaching Hospital "A. Gemelli" is located in Rome, and incorporates several postgraduate schools of medicine, including the School of Anaesthesia, Intensive Care and Pain Management. The training plan is competency-based and subject to satisfactory training progress and assessment over a five-year programme; recently, the Centre for Simulation and continuous medical education has been created and simulation-based training has been added to the students' curriculum. Serving both students and practising healthcare professionals from anaesthesia and intensive care disciplines, the Centre is a central resource

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The use of simulation-based training provides safe and effective procedures for the practice and acquisition of clinical skills needed for patient care. Medical education is required for the learning and training period in order to ensure patient safety especially in ICU. Artificial respiration education and proper setting of mechanical ventilation modes is primordial before application to the patient. The training necessitates the use of realistically simulated patients in order to prepare to a variety of real scenarios. The latter are limited when using mechanically lungs or animal-based training.

TestChest®, the physiologic controlled lung, provides a breakthrough in respiratory training and has the CE marking. It was developed by experts in mechanical ventilation and respiratory physiology and is manufactured by Organis GmbH (Landquart, Switzerland) for worldwide distribution.

The simulation of human cardio-respiratory system is extremely realistic and thus makes animal experiments for teaching purposes unnecessary. It can be used as stand-alone skill training station by easily connecting an intubation head for realistic respiratory simulation (intubation, NIV). It can also be easily connected with a complete human body simulator.

The respiratory flight simulator combines high-end technical design and mathematical modeling to create a complete solution for optimized learning of basic and advanced artificial respiration. It is the ultimate training tool for anesthesiologists, intensive care physicians and nurses. Through a variety of preconfigured scenarios and spontaneous breaths, the simulation of acute and chronic lung diseases is possible and real-time experience is guaranteed. TestChest® realistically replicates pulmonary mechanics (resistance, non-linear compliance), gas exchange and hemodynamic responses. It has a programmable FRC and allows the simulation of different types of spontaneous breathing to severely diseased lungs with operator-adjustable respiratory rate and occlusion pressure (P0.1).

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Figure 1. The simulator consists of two bellows system driven by a linear motor. A large volume ensures the simulation of a real human lung with realistic FRC and vital capacity. A basic control software created by AQAI Simulation Center (Mainz, Germany) allows the control of the motor and the setup of the artificial lung parameters.

Figure 2. The motor realizes nonlinear S-shape of the pressure-volume loop, recruitment and collapse of the lungs.

Figure 3. TestChest® includes sensors for alveolar pressure, airway pressure, and environmental pressure as well as an oxygen and temperature sensors. It is compatible with wet gases and it is equipped with a mass flow controller for CO_2 production, which together with an adjustable dead space permit the generation of realistic capnograms.

Figure 4. An artificial finger allows the simulation of oxygen saturation curves. The variation of pulse amplitude according to different intravascular fillings model heart-lung interactions supporting the testing of most advanced closed-loop ventilation modes. The flight simulator offers for its pilots (healthcare professionals) a realistic training environment to ensure the safety of patients.

that provides state-of-the-art facilities and equipment to support a variety of educational resources. ranging from basic psychomotor skills training to advanced, full-scale immersive simulation. The central idea is to integrate simulation immersion into the education of future anaesthesiologists as well as medical students and healthcare professionals in other specialties.

Simulation and CRM-based programmes have been developed in the following areas and disciplines:

- Anaesthesia and Operating rooms scenarios
- Intensive Care Medicine
- Obstetrical Emergencies
- Paediatric and Neonatal Emergencies
- In-Hospital trauma care
- Cardiopulmonary resuscitation and acute cardiac emergency care
- Rapid response systems
- Transport of critically ill patients
- Organ transplantation
- Clinical toxicology
- Disaster Medicine.

Simulation resources include a full scale simulation centre as well as an in situ Simulation Programme by means of a fully self-sufficient wifi mannequin. Simulations can be performed in any real clinical environment (operating rooms, A&E rooms, post-operative intensive care etc).

Sharing critical points raised during teaching sessions is essential for learning in medical education settings. This is particularly true in simulation-based medical education (SBME), which potentially creates high levels of stress in both instructors and trainees.

Debriefing has been shown to be an essential part of the simulation-based learning process. Savoldelli et al. (2006) demonstrated that simulation without debriefing is ineffective, because errors can be repeated if team members have not been informed that they were making mistakes.

In the last 20 years, the judgmental approach to debriefing, mainly based on the "shame-and-blame" method, has been strongly criticised and discouraged because of its severe costs in terms of humiliation, frustration and depressed motivation (Leape 1994a; 1994b). The non-judgmental model to debriefing has been widely practised using different strategies and approaches, such as the Socratic model (leading questions and "easing in") (Argyris et al. 1985) or the sandwich model (good things followed by points of improvement in a rigid sequence) (Weisinger 1989; Weisinger 2000).

Albeit the non-judgmental approach has the significant advantage of not hurting trainees' feelings, it has some important weaknesses. First of all, it fails to openly disclose major problems felt by both the teacher and the student. In other words, always giving priority to positive aspects is often felt as artificial especially when a critical point engages the trainee's attention. In poor trainee performances, showing a relentless optimism may convey the embedded message that mistakes are not able to be discussed, or possibly shameful.

"Reflective practice" is a term coined by Donald Schön (1983) to describe a method to improve personal and interpersonal effectiveness of professionals by examining the values, assumptions and knowledge base that drives one's own actions. Research in cognitive science (Torbert 1972; Senge 1990) and on reflective practice provides a conceptual model that guides teachers on how to discover the mental models that were used in guiding trainees' actions during the teaching session. Trainees' actions have always a logical sense if framed in the cognitive model used to get a result. According to this, mistakes are always or mainly caused by meaning-making systems of the trainees, such as their frames, assumptions, and knowledge. Using reflective debriefing the focus widens to include not only the trainees' actions, but also their mental models that ultimately determined the final result. Mistakes are not a source of shame and blame any more but a precious learning resource to be openly acknowledged and discussed.

"Optimal to control human factors and prevent medical errors"

Transparent talk about trainees' mistakes can be achieved by a three-step approach:

1. **Observation/description:** the teacher observes and describes the trainee's action;
2. **Comment/opinion:** the teacher offers his/her ideas;
3. **Mental model disclaimer:** the teacher shows his/her interest (curiosity) to discover the mental model that framed the student's action.

Reflective debriefing increases the chances that the student will be able to accept the teacher's feedback without being defensive and feeling psychologically safe. It provides trainees with a clear message about the instructor's point of view while reducing the background noise of misunderstandings and defensiveness that can be associated with judgmental and nonjudgmental approaches. ■

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Communication Matters

Communication is increasingly recognised as medicine's most important non-technical skill. Perhaps this is self-evident: after all communication is how humans exchange meaning, reduce complexity, address uncertainty, manage emotions, inform, encourage, comfort and challenge. Communication is also central to the human experience of illness, and therefore central to medical decision-making. However, it is also complicated, nuanced and, consequently, error-prone. Therefore it should not be left to chance, or always left to junior team-members. Fortunately, communication can be learnt, mastered and measured (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014).

If communication is defined as "sharing, uniting, or making understanding common" (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014), then better communication is key to creating systems that are more trustworthy and patient-focused (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014). Whereas intensive care medicine previously focused on scientific discovery and technological advance, medicine can also be understood as a complex social system (Brindley 2010). Therefore intensive care medicine should now also make a "science of reducing complexity" and a "science of managing uncertainty" (St Pierre et al. 2008; Brindley 2010). Much of this will be achieved (or squandered) by how well we talk and listen. Furthermore, patients often come to intensive care units (ICUs) following bad outcomes and bad decisions: not just bad pathology. Therefore, we are as much a Relationship Repair Unit (i.e. an RRU) as an ICU (personal communication, J Ronco). Overall, communication becomes one of our most potent 'therapies', and how we coordinate (or fragment) ongoing care, bolster (or impair) cooperation, and grow (or erode) trust (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014; Brindley 2010; Aron and Headrick 2002; Azoulay and Spring 2004; Azoulay et al. 2000).

This review cannot exhaustively cover (or comprehensively reference) a topic as capacious as communication. Therefore healthcare professionals should read widely. The goal should be to deliberately develop communication skills throughout our careers: such that 'verbal dexterity' matches manual dexterity and factual know-how (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014; Brindley 2010). This is because being an expert clinician now means being a skilled communicator (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014; Brindley 2010; Aron and Headrick 2002; Azoulay and Spring 2004; Azoulay et al. 2000). These skills will enhance difficult decision-making: whether during acute medical crises; during handover with colleagues, or, as is this article's primary purpose, during discussions with patients and surrogates.

Medical Communication: The Basics

Communication skills are rarely innate, and do not necessarily improve through years of unstructured experience (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014). Similarly, communication is not one-size-fits-all, nor a panacea. However, communication training is associated with increased confidence, improved patient satisfaction, less anxiety, decreased depression and lower post-traumatic stress (eds Cyna et al. 2011; Dunn et al. 2007; Leonard et al. 2004). Communication can be a 'placebo' (i.e. good communication can reduce pain and anxiety) or 'nocebo' (i.e. bad communication can increase pain and anxiety) (eds Cyna et al. 2011). Better communication might also decrease litigation and maintain hospital reputation (eds Cyna et al. 2011). Accordingly, communication is everybody's business: it should be taught to trainees, expected from practitioners and supported by administration (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014).

Communication is about listening as much as talking. When we do talk it is also about more than just what words are used (aka verbal communication) (St Pierre et al. 2008). We should also master good paraverbal communication: how words are said (pitch, volume, pacing and emphasis). Moreover, while this review focuses on verbal communication, non-verbal communication is just as important. This includes appropriate body language, suitable eye contact, response to emotions, the use of reflective silence and active listening (see below). We really cannot not communicate: failing to make the effort sends its own message (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014).

Why Communication (and Decision-Making) Is Often Difficult

Shannon and Weaver, working for Bell Laboratories, developed a model for verbal communication still relevant to medicine decades on (St Pierre et al. 2008). Simply put, transmitters (i.e. speakers) encode messages, and receivers (i.e. listeners) decode them. However, both must be on the same channel (which in medicine could mean possessing similar situational awareness and emotional states), and there should be minimal interference (which in medicine could mean minimising chaos, stress, or cognitive bias). They also identified the danger of 'channel-overload' (which in medicine warns against communication

that is unnecessarily complex). Overload, which often results in indecision, also occurs unless the receiver can filter data into usable information: You receive data ("his blood pressure is low"), but need to create usable information ("his body is failing") (St Pierre et al. 2008).

Shannon's model has limitations. Complex communication also requires meaning, which

"Communication becomes one of our most potent 'therapies'"

is harder to encode, transmit and decode. This is one reason why we cannot assume that patients and surrogates have reached the same conclusion as medical practitioners (St Pierre et al. 2008). This in turn explains why doctors are commonly criticised for failing to say what they mean, or mean what they say ("did you ever actually say 'he is dying'?"). This model also describes communication as unidirectional (transmitter to receiver), whilst medical decision-making is commonly multi-directional, across disciplines and across hierarchies (St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014). Location should not affect data transmission, but it affects communication quality, impact and efficiency. For example, when transmitter and receiver are no longer face to face communication loses important non-verbal cues (St Pierre et al. 2008). This is why the medical telephone call is important to practise, and why confirming understanding by routinely summarising and repeating back is an important fail-safe (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011; Brindley et al. 2014).

Newer communication models focus on relationships, not just tasks. The 'four mouths and four ears model' (St Pierre et al. 2008) has sender and listener separated by a message with four equal sides: i) content; ii) relationship; iii) self-revelation iv) appeal (St Pierre et al. 2008). Content refers to facts and words. The relationship aspect means that senders reveal (consciously and unconsciously) how they regard receivers through specific words, intonations and non-verbal signals. Senders also indicate how they feel about themselves, namely a 'self-revelation'. Fourthly, there is an appeal (or request) where messages encourage the receiver to do (or not do) something. These four aspects apply to both talker and listener, namely we 'speak with four mouths' and 'listen with four ears'. This is often unconscious, and depends upon mental state, expectation, and previous interactions (St Pierre et al. 2008). Notably the sender cannot fully force the listener's mind (and vice-versa). A practical example follows:

> When a doctor says to a patient or surrogate: "What do you want me to do?" the doctor may presume he asked a unambiguous question which respects autonomy. Perhaps he did, but intonation can suggest otherwise. He may also have revealed his inability to make difficult decisions or even frustration about the patient's premorbid state ("it's too late…what do you expect me to be able to do!"). Also, the doctor's self-revelation could be one of either appropriate patient concern or resignation ("I don't have the time/training/authority for these complex cases…just tell me what do you want"). His request or appeal (albeit unstated) might be to try to subtly persuade the family ("I'm not sure ICU would be best"). In contrast, senior doctors may wish to minimise the patient/surrogate's sense of responsibility/guilt. In this case, communication should unequivocally state what they believe is not appropriate but also what can be done ("life support doesn't treat this so won't be offered. Instead, we will treat reversible conditions and maintain comfort").

The surrogate decision-maker also listens with four ears, and any one can be more or less open. For example, a content-based response would respond with objectivity ("I want everything"). If the family member hears the self-revelation he might reply: "she's been through a lot, but she's a fighter". If the family member is attuned to relationship aspects, or has previous disappointments from the medical professions, then they may be more defensive ("You doctors give up too easily: I want everything"). Only rarely will the listener have the state of mind to decipher the appeal: "so what I think you're telling me is..". Regardless, this model shows how communication can create a virtuous cycle that builds cooperation, or a vicious cycle that destroys it (St Pierre et al. 2008; Brindley and Reynolds 2011).

Communication is affected (both in meaning and interpretation) by the paraverbal (volume, tone, pitch, pacing) and non-verbal (angry eyes; furrowed brow) (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011). These in turn are affected by subconscious emotions and attitudes. If verbal and non-verbal are incongruent (words say one thing; expressions another), then receivers typically deemphasise words, and amplify the importance of tone and body language. With incongruence receivers typically default to what they (or we) expected ("he said X, but I know what doctors mean"). Incongruence promotes misinterpretation, and can be interpreted as disingenuous (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011). Congruence is even more important when those involved are unfamiliar, or when the medical situation is novel, which is almost always for families! Investing the time to establish 'rapport' (usually defined as 'common perspective'; 'being in sync' or 'shared mental model') can facilitate all future interactions (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley et al. 2014). The effort demonstrated can also reinforce the patient's psychological reserves and resilience (eds Cyna et al. 2011; St Pierre et al. 2008; Brindley and Reynolds 2011).

Helping Patients and Surrogates Feel Safe to Communicate

As popularised by Pincince (2013) and others, decisions are best made when people are not in hot emotional states (anger, stress). To 'cool' emotions, patients and surrogates need familiarity, which can be undermined by changing staff too frequently; predictability, which can be threatened by keeping families waiting; intact support systems, which can be destabilised if families feel excluded and a sense of control, which can be weakened by illness and unfamiliarity. Hot emotional states lead to anger or intransigence (aka 'neural hijacking of the rational brain'). The psychologist Stephen Porges explains this idea using the polyvagal theory: when calm our vagus nerve can facilitate engagement; when angry it stimulates conflict (Porges 2011). These ideas apply to those that cannot talk (endotracheal tube; stroke), and those that do not talk (fear, confusion, deference) (eds Cyna et al. 2011; Brindley et al. 2014). For patients already burdened with illness, not being able to verbalise, and not being understood, can accelerate a downward spiral into frustration and disengagement. Also when healthcare workers do speak we may speak differently than patients (eds Cyna et al. 2011). Physicians often use technical language and focus upon gathering information and delivering news. Patient language and surrogate language often focuses on beliefs, fears and hopes, which explains why they may cling onto any positive news ("so it's not the worst you've ever seen!"). Patient and surrogate coping strategies may include denial or aggression, whereas caregivers intellectualise to protect emotions. Communication that is sensitive, but objective, can bridge the caregiver's 'scientific world' and the care-receiver's 'natural world' (eds Cyna et al. 2011; Brindley et al. 2014).

Communication Tools That Can Aid Decision-Making

Especially when communicating bad news, doctors and nurses should understand that, while routine for us, for families these are sentinel moments, unlikely to be forgotten (eds Cyna et al. 2011; Brindley et al. 2014). Combined with 'active listening' (where listeners pay close attention and use feedback or rephrasing to demonstrate engagement and understanding), the effort put into communication is a way to demonstrate non-abandonment (eds Cyna et al. 2011; Brindley et al. 2014). Communication tools and bundles (see below) can also provide structure and reliability to complex communication. However, they should never make interactions robotic and devoid of personal connection.

We also have tools to audit communication with patients and surrogates (Black et al. 2013; Davidson et al. 2007). Black et al. (2013) promoted a communication bundle with six requirements within 24 hours: identification of i) the surrogate-decision maker; ii) code status; iii) advance directive; iv) pain v) dyspnoea, and also vi) distribution of a brochure. Four additional goals should be met within 72 hours: i) family meeting, ii) discuss prognosis, iii) assess patient-specific goals, and iv) offer spiritual care. This approach emphasises that decision-making requires more than just data transmission. Patients are validated as people with values (not just diseases) and part of a larger 'life-support system' that includes family, friends and community (eds Cyna et al. 2011; Brindley et al. 2014 Black et al. 2013; Davidson et al. 2007). All of the above should also explain why patients and surrogates value clinicians' communication skills at least as much as their technical skills (Heyland et al. 2002). For difficult decision-making (and even for simple decision-making!) communication is likely our greatest clinical asset, or keenest liability. ■

Key Messages

- Communication is central to the human experience of illness, and therefore central to medical decision-making.
- Being an expert clinician now means being a skilled communicator.
- Fortunately, communication skills can be learnt, mastered and measured.

The Calgary-Cambridge guide (Silverman et al. 2005; Kurtz et al. 2003) divides communication into:

1. Initiate;
2. Gather information;
3. Provide structure;
4. Build relationships;
5. Explain and Plan, and
6. Close the Session.

The GREAT acronym (eds Cyna et al. 2011) consists of:

1. Greetings/Goals;
2. Rapport
3. Evaluation/Expectation/Examination/Explanation;
4. Ask/Answer/Acknowledge;
5. Tacit agreement/Thanks.

The LAURS acronym (eds Cyna et al. 2011) consists of :

1. Listening;
2. Acceptance;
3. Utilisation (of appropriate words);
4. Reframing, and
5. Suggestion.

The VALUE acronym (eds Cyna et al. 2011; Curtis and White 2008) divides communication into:

1. Value statements from family;
2. Acknowledge emotions;
3. Listen;
4. Understand the patient as a person;
5. Elicit questions can facilitate shared decision-making.

The SPIKES acronym is recommended when delivering bad news (eds Cyna et al. 2011; Baile et al. 2000), and divides communication into:

1. Settings;
2. Patient perception;
3. Invite to share;
4. Knowledge transmission;
5. Emotions and Empathy;
6. Summarise and Strategise.

Note

This article is adapted from a more comprehensive review of high-stakes medical communication in the *Handbook of Intensive Care Organization and Management* (Editors A. Webb and G. Ramsay; publication pending).

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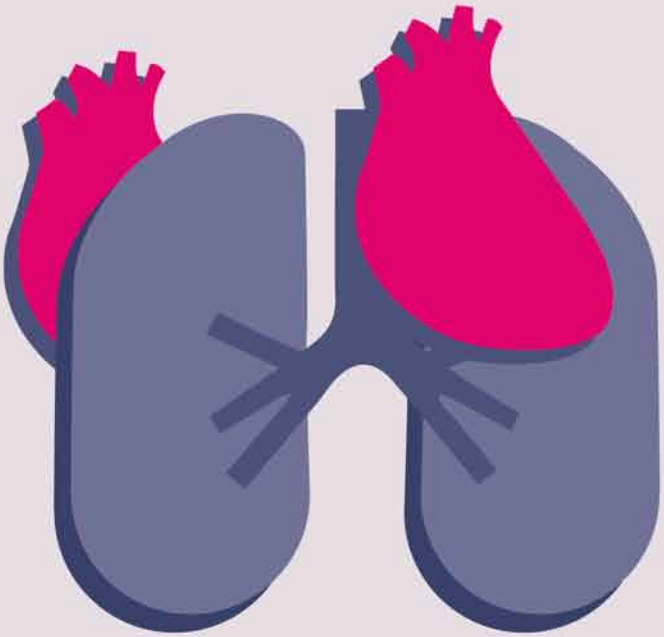

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PARTNERING MEDICINE AND PUBLIC SERVICE

INTERVIEW WITH PROFESSOR PAUL E. PEPE

Paul E. Pepe, MD, MPH, is Professor with Tenure in Internal Medicine, Surgery, Pediatrics, Public Health & Emergency Medicine (EM) at UT Southwestern and the City of Dallas Director of Medical Emergency Services for Public Safety, Public Health & Homeland Security. Up until this spring, he served for more than a decade as the jurisdictional Medical Director for the regional EMS system (about 250,000 annual emergency incidents, involving about 3,000 paramedics/first responders in Dallas and 18 surrounding cities) and he was recently appointed to become Regional Director for Out-of-Hospital Mobile Care Systems and Disaster/Event Preparedness at the University, a state government institution. For the past three and half decades, he methodically brought critical care medicine to the streets of North America in cities such as Seattle, Houston and Dallas where he has practised on-scene prehospital medical care and conducted ground-breaking investigations. Prof. Pepe joined the Editorial Board of ICU Management in 2014.

Over the past 18 years, you have combined an academic chair role in emergency medicine with public service roles in emergency medical services. How does practice inform research in these roles?

Participation in academia and in public service is complementary in many ways. In academia, our purpose is to scientifically make improvements in patient care and teach those advances to the trainees, but, in the end, the mission is to serve the public. Public officials are, de facto, serving the public, and so there is a common mission. I have been very fortunate to work with visionary elected and managerial public officials, who have seen the benefits of working hand in hand with academia. The academic world has the tools to study, document and verify appropriate uses of public resources. This is not only facilitated by researchers who routinely evaluate interventions scientifically, be they medical care or procedural innovations, but also by their ability to secure extramural funding and grants.

When you have visionary public officials, those changes can be implemented more rapidly, particularly when the data are generated to back up the funding needs and resource allocation. A classic example is in the arena of resuscitation medicine. Public resources (e.g., paramedics and first responders) can be used to research how to save more lives in the realm of cardiac, trauma and STEMI resuscitation as well as stroke recovery and a myriad of other critical illnesses and injuries. In order to conduct scientific studies in patients with these critical conditions, it often entails the need to implement an exception to informed consent (ETIC) due to the nature of the life and death decisions that need to be made within minutes – or even seconds. Even if the family were present, any consent would be given under duress and therefore would not be considered truly informed consent.

In turn, there are now accepted policies to provide ETIC under such circumstances. Nevertheless, to politically, sociologically and ethically conduct a study involving ETIC, it is critical to have the involvement and prospective knowledge and consensus of public officials, the medical community, the media and other advocates for our patients.

By being an integral and trusted part of local government, one can communicate and interact with other public officials, the media and public health officers on a regular basis,

thus facilitating that trust and a working knowledge of activities. This is very important because public leaders are incredibly busy and are continually bombarded with multiple other proposals to analyse. To have a daily interface, even if briefly, enhances the ability to get things explained, accepted and accomplished. For example, we had an incident where we were going to be dismissed from a particular clinical trial by the national centre because of lack of compliance in a particular metric. A single phone call to the lead public official in the city was able to turn things around by prioritising the focus on meeting those compliance standards despite being in the midst of budgetary crisis. That would not have happened had I not been part of that government organisation on a day-to-day basis and gained the respect and confidence of the final decision makers.

This association between academia and public service also benefits the tax-paying citizens at large, because our ability to bring in extramural grants means that we can implement changes and obtain new life-saving equipment and monitoring devices to help better document the life-saving interventions and procedures. As a result, over the past ten years, we have been able to demonstrate dramatic improvements in survival for conditions such as cardiac arrest, STEMI, stroke and trauma and at no direct cost to the citizens in our community. It is a public official's dream to be able to improve public safety and public health without costing anything, so a mutually beneficial two-way street is facilitated by my living in those two worlds simultaneously.

You are on record as "proud to serve" as a public servant. You are also generous with your time in talking to mass media. Why are these roles important for a physician?

When people ask what I do for a living, the reply that comes to mind first is "I'm a public servant". I have worked for state and/or municipal governments for the last 30 years. It just happens that I have some special talents or competencies in the realm of medical care. Even if I were not working in government, I still see my role as a physician as providing service to the public.

In Dallas, we have partnered with the mass media in our efforts to study life-saving interventions. Long before we began to do clinical trials, I started working with the county and city governments and news media alike. Even then, I was explaining to them the inadequacies of historical controls and why you need prospective controlled studies. We also educated them how the design of clinical trials would not only be done in a fair manner, but that everyone, including traditionally underserved populations, would get equal access. In other words, everyone gets a 50/50 shot at the new intervention regardless of who they are.

Most importantly, we have documented dramatic improvements in outcome for the control group simply because of implementing the trial. When I introduce any new studies we are doing, I always explain what happened with the last one. Consistently, and regardless of the study outcome, the survival chances go up for everyone who was enrolled, whether they were in the control or study group. Also, when I am examining the ethical and scientific decisions about whether I should conduct a trial, I always ask myself, "Would I enter my child or my mother in this study?" When I can truly feel that way and articulate it accordingly, there is immediate "buy-in" now.

Armed with the prior study's data and earning their trust over the years, it helps me to accomplish even more life-saving – all because I had established longstanding routine interactions with other public officials, the media and, in turn, the public at large.

"A good leader is basically a person who is trusted"

In terms of a specific new study, education of media and public officials cannot be done by someone they barely know in a quick sound bite manner, whether for a first-time press conference or for a public committee meeting. One needs to educate those public advocates well ahead of time. I usually do it one-on-one with each of them, making the rounds to each TV news director or city council member. Eventually, I usually bring these leaders together in a closed conclave in one room for what I call the Dallas community consultation committee. The committee is made up of news directors, elected officials, congress members, county supervisors, the medical society and public health officials. We actually have great discussions and everyone loves to come to these meetings of the minds. We have convened this group, not only regarding research, but also to talk about things like what are we going to do if there is a big pandemic or nuclear explosion and how we plan to organise – and triage – in mass critical care scenarios. Because of these thoughtful joint discussions about these sensitive issues, we have helped to pre-empt knee-jerk responses to well thought-out strategies. Instead of being criticised after the fact in a very shallow way that we are creating 'death panels', or that we are experimenting and treating people like 'guinea pigs', these public advocates come to better understand the process, intent and wisdom of what we are planning – and not under the duress of an actual event. More importantly, they help to guide us in a very responsible manner. They know how carefully we arrived at some very difficult conclusions. Accordingly, I make sure that it is well known that the public officials and the media were partners in the life saving effects in this community and that they should be credited for their wisdom and visionary involvement.

Also, I often point out that in day-to-day emergency care, the treatment you might be provided is generally not known to the average person or that it may be altered depending on the practitioner involved. When I do the study, however, the protocol is public record and people know exactly what we are going to be doing. So the care provided is quite transparent. Secondly, everybody in this community, no matter what background they come from, is treated the same way. For example, when we talk about the issue of mass critical care in which we may have to make some very difficult triage decisions, we point out that our consensus-based protocols are available to the public at large and everybody will be treated the same way. In other words, wealth will not determine the level of care. Instead, we created a level playing field and this engenders additional trust. Again, pre-emptive education of the community consultation committee members will help to significantly mitigate mistrust in a future crisis.

What should future priorities be for cardiac and resuscitation research?

What I am currently working on involves different ways to actually improve flow even further. I am beginning to focus on situations in which there has been a really serious anoxic insult, particularly in those who have had a long cardiac arrest interval, say 5, 10, or 15 minutes without any intervention.

In the past, such conditions would have been seen as irretrievable. However, our new intrepid experiments show a different way of thinking about things – instead of a focus on restoring an adequate coronary perfusion pressure, I am thinking about restoring better coronary and systemic flow.

Without getting into the specifics of what we are doing, I would simply point out that we now believe that we may indeed be able to resuscitate and send home persons neurologically intact despite such anoxic insults. Consequently, we will increase survival rates even further because we are dealing with a very large population of patients who currently do not survive.

What are the most promising technologies for EMS?

We are now beginning to show that quality CPR monitoring devices and flow-enhancing adjuncts, such as the active compression-decompression pump and the impedance threshold device, improve outcomes. Another technology that shows promise is Trans-Oesophageal Echocardiography (TOE), because it may help us to see if the heart is still beating in the absence of a detectable pulse. Also, if we see that the heart is not beating we can feel more comfortable in terminating resuscitation efforts. The most interesting and latest twist is that, with TOE, you may find the most optimal position to place one's hands in order to improve the vector of the outflow during CPR. Perhaps, eventually, with other adjuncts, we will be able even to look at how we are improving blood brain flow. In terms of the quality of CPR, we really have started to do some fine tuning that has saved lives. For example, the so-called "sweet spot" of chest compression rate might be around 110 with standard CPR, but with adjuncts such as the impedance threshold device, that rate might be 90.

How do you define success in an EMS/ICU director?

One of the things I have learned is that where we thought that improved survival rates, improved protocols and cost-effective procedures were traditionally thought of as defining success of a medical director for a critical care unit, whether the unit is a typical ICU unit or one out on the streets, success is actually how you deal with and navigate through the daily political, and/or logistical problems that come up - whether it's patient complaints, budgetary obstacles or bad interactions with colleagues. How you handle those different obstacles on a day-to-day basis is what really defines a good leader. Some might also say that critical care medical directors (be it EMS or ICU) who handled those obstacles and challenges well served for long periods of time and thus were able to have the better opportunity to improve outcomes. Leadership doesn't require just being a nice person. It also requires being competent, having the data and at the same time being willing to understand the other person's side and needs and being able to accomplish mutual goals for the patient's sake. Ultimately it means being seen as a sincere patient advocate and not just someone looking out for his or her own needs. Simply, you are a team looking out for the patients. What defines a good leader is basically a person who is trusted.

You say that a gram of good pre-hospital care saves a kilogram of ICU care. Why is that?

My mantra over the years has been, "the earlier the intervention, the better the results". For example, we introduced automated defibrillators at the airports in Chicago fifteen years ago. In the first year of implementation all nine people who collapsed in the counter and gate areas, where we had placed devices, survived neurologically intact. Most of them were waking before traditional EMS arrived. In the past, even if there was bystander CPR and rapid resuscitation by the medics, the patients still would be in a coma and remain in coma requiring intubation and mechanical ventilation in the ICU. Half of them would wake up — and half of them would not. Now, with such an intervention being provided so much earlier, by the public no less, it is a profound experience when every one of them is not only saved, but is waking up before arrival of paramedics. That was a classic example of "the earlier an intervention the better the results" and also the corollary, "a gram of good prehospital care saves a kilogram of ICU care" (Caffrey, et al. 2002).

Another example is using Continuous Positive Airway Pressure (CPAP) in the field; we have learned that if we introduce CPAP early on we can prevent intubations. This means not only taking CPAP to the streets and in the ambulance, but into homes. With portable CPAP devices, we were able to prevent several hundreds of people from being intubated, once again because the earlier the intervention, the better result. By acting, literally within minutes, before the flash pulmonary oedema can progress too far, it is easier to reverse. The reason why this is so important is that it not only spares ICU resources, personnel and equipment, leaving ICU beds open, but it also prevents complications such as ventilator-associated pneumonia (VAP). As we are supposed to be accountable care organisations nowadays, this intervention does exactly what we want; we save money, spare resources and decrease the incidence of complications such as VAP. But, most importantly, we improve patient satisfaction. If this was my mother and she suddenly has flash pulmonary oedema and is drowning, she is terrified. But, then, if we have to come along and put a tube in her lungs in a very dramatic moment at the hospital, because of progressing lung and heart failure, she may ask to just let her die next time. Instead, today, we can come along and put a noninvasive mask on the patient's face, and in moments they begin to feel much better.

In the end, that to me is what it is all about — providing better care for our patients and not just better management or treatment for our patients. ■

Reference

Caffrey SL, Willoughby PJ, Pepe PE et al. (2002) Public use of automated defibrillators. N Engl J Med, 347(16): 1242-7.

CRITICAL CARE MEDICINE IN KOREA

THE PAST, THE PRESENT AND THE FUTURE

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History of Critical Care in Korea and the Korean Society of Critical Care Medicine

The first intensive care unit (ICU) in Korea was established in 1968 with six beds in a university hospital in Seoul, and the number has since expanded to 220 ICUs taking care of 3197 patients (data from a one-day survey in 2009). As in other countries, such as Dr. Peter Safar in the United States and Dr. Bjorn Ibsen in Denmark did in the early 1950s, anaesthesiologists played an important role in starting critical care in Korea. The first ICU in Korea was established and run by an anaesthesiologist, Dr. Oh HK.

The foundation of the Korean Society of Critical Care Medicine (KSCCM) (http://ksccm.org/eng) accorded with the foundation of the Western Pacific Association of Critical Care Medicine (WPACCM). Korean delegates attended the meeting of the WPACCM, which was held in Tokyo on 26 July 1980. After the meeting the KSCCM was established on 19 December 1980 by over 30 founding members. Although the pioneers of critical care in Korea were anaesthesiologists, the founding members of KSCCM came from many different specialties (emergency medicine, surgery, pulmonology, cardiology and paediatrics). The first chairman of the board was Dr. Lee HJ, a cardiologist (the first president was Dr. Kim WS). The number of KSCCM members has expanded to approximately 1900 in 2015 (see Figure 1).

The first Scientific Congress of KSCCM was held in 1981 and the *Korean Journal of Critical Care Medicine* (http://www.kjccm.org) started publishing in 1986. In 2004 the 13th Congress of the Western Pacific Association of Critical Care Medicine was held in Seoul, focusing on "Mutual Understanding and Development in WPACCM". Over one thousand attendees participated in the congress.

Critical Care Medicine Specialty Board and Training System

The *Textbook of Critical Care Medicine* was published by the KSCCM in 2006, which is the cornerstone of training for the critical care board. On 15 April 2008, the KSCCM started the critical care specialty board of Korea, which was endorsed by the Korean Academy of Medical Societies. The critical care subspecialty is supposed to be renewed every five years. With the stimulus from the critical care specialty board, a formulated critical care training system has been implemented in Korea, mostly in teaching hospitals. The number of board-certified intensivists has increased to 1399 in 2015.

To ensure education of the trainees, two review courses are provided by the KSCCM. One is the Basic Critical Care Review Course (BCCRC), which was started in 2008; the other is the Multiprofessional Critical Care Review Course (MCCRC) Korea.

> **"A formulated critical care training system has been implemented"**

International Relationships

Joint Congress of the KSCCM and the Japanese Society of Intensive Care Medicine (JSICM)

The first joint congress of the Korean and Japanese societies was held in 2001 in conjunction

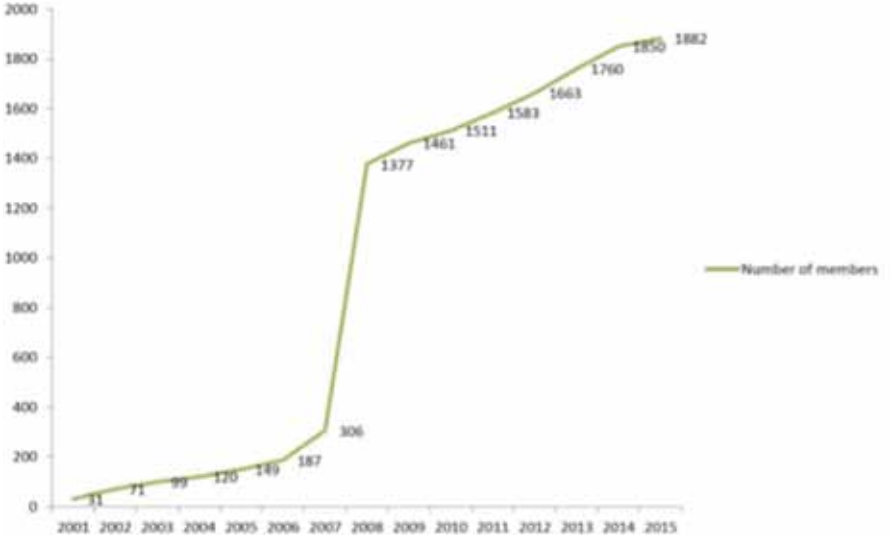

Figure 1. Number of KSCCM Members

with the 20th anniversary of the KSCCM. The two societies decided to continue the biennial joint congress and now the hosting society takes turn every year. The alliance between the two countries has evolved into performing joint collaboration research. The first collaborative research was published in Critical Care in 2012 (Lee et al. 2012).

Multiprofessional Critical Care Review Course (MCCRC) Korea

The Multiprofessional Critical Care Review Course (MCCRC) Korea began in September 2009 in Asan Medical Center. The MCCRC is held by the Society of Critical Care Medicine (SCCM) in collaboration with partnering critical care societies worldwide. The MCCRC Korea was the first review course run outside of the United States by SCCM and now it has spread to Saudi Arabia, Japan, China, and Brazil.

World Federation of Societies of Intensive and Critical Care Medicine (WFSICCM)

In 2015 the 12th Congress of the WFSICCM will be held in Seoul, Korea, with the motto of "One Step Further: the Pursuit of Excellence in Critical Care". Over four hundred abstracts have been submitted, and approximately 220 speakers have accepted invitations so far.

Statistics	
Total population (2013)	**49,263,000**
Gross national income per capita (PPP international $) (2013)	**33,440**
Life expectancy at birth m/f (years)	**78/85**
Probability of dying between 15 and 60 years m/f (per 1,000 population)	**2,321**
Total expenditure on health as % of GDP	**7.5**

Source: World Health Organization Health Observatory http://www.who.int/countries/kor/en/
Statistics are for 2012, unless otherwise stated.

Future Initiatives of KSCCM

The KSCCM has conducted much of its work to set up a high standard of critical care in Korea.

Improving patient safety and patient/family-centered care should be the future directive of KSCCM to achieve this mission. Moreover, the nationwide spread of standardised care in ICUs based on the best available evidence could be the starting point of better healthcare in Korea. The KSCCM has also developed partnerships with societies in developing countries by providing educational opportunities.

Directory

Korean Society of Critical Care Medicine
http://ksccm.org/eng/

Korean Society of Anesthesiologists
http://www.anesthesia.or.kr/eng/

Korean Society of Emergency Medicine
http://www.emergency.or.kr/english/

Reference

Lee BH, Inui D, Suh GY et al. (2012) Association of body temperature and antipyretic treatments with mortality of critically ill patients with and without sepsis: multi-centered prospective observational study. Crit Care, 16(1): R33.

HOT TOPICS IN CRITICAL CARE MEDICINE IN KOREA

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12th Congress of World Federation of Societies of Intensive and Critical Care Medicine (WFSICCM)

This year, the 12th Congress of the World Federation of Societies of Intensive and Critical Care Medicine (WFSICCM Seoul 2015 Congress), in collaboration with the World Federation of Critical Care Nurses (WFCCN) and the World Federation of Pediatric Intensive and Critical Care Societies (WFPICCS) will be held from August 29 to September 1, 2015 in Seoul, Korea. This will be the second time the congress is held in Asia, where intensive and critical care medicine has undergone a marked development over the past decades.

The total number of submitted abstracts to the WFSICCM Seoul 2015 Congress is 560 from 47 countries (see Table 1). There will be more than 100 sessions in a variety of topics in multiple formats at the Seoul congress. And approximately 280 speakers and chairs from 50 countries have accepted invitations so far.

The WFSICCM Seoul 2015 Congress is being prepared under two main themes:

'One Step Further': The first theme brings forward a message that WFSICCM Seoul 2015 is the place where all participants can improve their medical abilities in a practical manner and further advance mutual understanding with other critical care providers working in different circumstances.

'Get Together': Under this second theme, we have supported intensivists from countries with limited medical resources in their participation in the WFSICCM Seoul 2015 Congress. Supported physicians and nurses from resource-limited countries will obtain practically usable knowledge throughout the sessions. During the sessions such as 'Meet the Experts', 'Panel Discussions' and 'Workshops', they can share with other participants and field experts medical case studies or difficulties they have faced in their countries.

In addition a number of workshops will be organised during the main congress to help participants attend the sessions more conveniently. These sessions are designed to inspire participants to learn novel knowledge while experiencing new devices and medical technologies.

The Committee promises to put its utmost effort to provide the high-quality experience of large-scale exhibitions and also enjoyable social events where you can establish a new global network.

With a view to highlighting the role of the Korean Society of Critical Care Medicine (KSCCM) as an invaluable source of support in advancing science and education throughout Korea and beyond, we feel more than convinced that the WFSICCM Seoul 2015 Congress will become essential on account of its coordination function and responsibility in providing the most up-to-date information to meet the needs of participants from all over the world.

> "large variability in the number of ICU specialists"

Variability of Standards among ICUs in Korea

Currently one of the important problems is the variability of standards among ICUs. There is especially large variability in the number of ICU specialists, because we do not have legal obligations for intensivist staffing (see Table 2). We still need more intensivists now. However, insufficient reimbursement has led to the fact that hospital management does not want to invest in ICUs.

In addition the patient-to-nurse ratio is highly variable according to ICU type and hospital size. The shortage of ICU nurses has increased workload and led to burnout. We have a high turnover rate of ICU nurses.

Quality Assessment for ICUs in Korea

Given that the reimbursement system is 'fee-for-service' in Korea, there is a risk of providing more healthcare services than needed, or there being unacceptable variation of healthcare services between institutions. The Quality Assessment Service is a systematic method of assessing the clinical validity and cost efficiency of medical and pharmaceutical services, which is conducted by the Health Insurance and Review Assessment Service (HIRA). From 2000 to 2013, a total of 30 items, including acute diseases, chronic diseases and degree of service utilisation has been assessed. Finally, quality assessment

Continent	Country	Abstracts
Africa (11)	Egypt	2
	Ethiopia	1
	Nigeria	4
	South Africa	3
	Uganda	1
Asia & Middle East (476)	Bangladesh	1
	China	23
	China, Hong Kong	2
	India	21
	Indonesia	12
	Iran	1
	Israel	2
	Japan	103
	Korea, Republic of	208
	Malaysia	1
	Nepal	3
	Pakistan	10
	Peru	2
	Philippines	1
	Singapore	12
	Taiwan	23
	Thailand	12
	Turkey	32
	UAE	1
	Qatar	4
Europe (23)	Belgium	4
	Cyprus	Cyprus
	Czech Republic	2
	Denmark	1
	France	2
	Germany	2
	Netherlands	1
	Portugal	1
	Russian Federation	2
	Ukraine	4
	United Kingdom	2
North America (26)	Canada	4
	United States	20
	Mexico	2
Oceania (11)	Australia	8
	New Zealand	3
South America (13)	Argentina	3
	Brazil	3
	Chile	4
	Colombia	2
	Uruguay	1
TOTAL		560

Table 1. Submitted Abstracts for WFSICCM Seoul 2015 Congress

for ICUs was carried out from October to December 2014.

All ICUs of general or teaching hospitals were subject to assessment. Quality assessment indicators were used to describe the structure, process and outcomes. Some examples of quality assessment indicators were as follows:

- Intensivist staffing;
- Patient-to-nurse ratio;
- Reporting and analysis of standardised mortality ratio (SMR);
- ICU re-admission rate within 48h of ICU discharge;
- Rate of central venous catheter-related blood stream infection;
- Rate of ventilator-associated pneumonia et al.

Assessment results will be disclosed to the public in late 2015.

We hope that this quality assessment service will minimise the variance of ICU treatment among institutions and improve the quality of ICU care in Korea.

	Total No. of Units Responding	Empowered MD NO.	%	Full-Time MD No. (Specialist)	% (Specialist)
ICU Type					
CCU	18	17	94.4	4 (4)	72.2 (22.2)
Medical	60	57	95.0	40 (4)	66.7 (6.7)
Surgical	48	43	89.6	29 (5)	60.4 (10.4)
Neurologic	23	22	95.7	13 (1)	56.5 (4.3)
Paediatric	38	38	100.0	38 (21)	100.0 (55.3)
Emergency	7	6	85.7	6 (1)	85.7 (14.3)
Mixed	26	23	88.5	17 (1)	65.4 (7.7)
Total	220	206	93.6	156 (38)	70.9 (17.3)
Hospital Type					
Public	41	41	100.0	30 (4)	73.2 (9.8)
Private	179	165	92.2	126 (34)	70.4 (19.0)
Hospital Bed Size					
Less than 500	21	19	90.5	9 (0)	42.9 (0)
501-1000	137	126	92.0	95 (15)	69.3 (10.9)
More than 1001	62	61	98.4	52 (23)	83.9 (37.1)

Table 2. Number of ICU Specialists According to ICU Type, Hospital Type and Hospital Size
Source: National Survey conducted by KSCCM in 2009

WORLD FEDERATION OF SOCIETIES OF INTENSIVE AND CRITICAL CARE MEDICINE

INTERVIEW WITH PROFESSOR JEAN-LOUIS VINCENT, WFSICCM PRESIDENT

Jean-Louis Vincent
Editor-in-Chief
ICU Management
Head Department of
Intensive Care
Erasme Hospital / Free University of
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Brussels, Belgium
jlvincen@ulb.ac.be

What have been the highlights of your term of office?

With modern communication means, it is easier to interact all over the world, to know each other better, and learn from each other. We have started the organisation of large trials, inviting the entire word to contribute – the ICON study has been a great success! We have put several task forces in place – on triage problems, end-of-life practices, definitions of ICUs and the requirements to be considered as an ICU specialist.

WFSICCM's mission is "to promote the highest standards of Intensive and Critical Care Medicine for all mankind, without discrimination." How does the Federation implement that in practice?

We are working on guidelines and recommendations – our website is an excellent means of communication. Our world congress is a good way, and we anticipate the meeting in Seoul will be excellent.

A WFSICCM Task Force will develop global guidance on "What is an ICU?" Can you expand on this?

There is a lot of heterogeneity in ICU: big ICUs combining very sick and somewhat less sick patients; separate intermediate care units; when is an intermediate care unit no longer considered an ICU? What about intermediate care units, which are geographically separate, and managed for example. by neurosurgeons or cardiologists or gastroenterologists? The Task Force will address these issues.

What can intensivists in high-income countries learn from colleagues in resource-limited countries, and how can they assist?

It is interesting to imagine how our work would be in austere conditions. Can we develop simple interventions?

They can assist by providing guidelines applicable in austere conditions. Selling older material has never been very helpful, as maintenance can be a limiting factor, and there are other problems.

The WFSICCM Congress in Seoul will include a session to support physicians and nurses from countries with limited medical resources. What do you hope it will achieve?

We have the duty to help our colleagues to organise in the absence of sophisticated monitoring and management systems. They have many questions we need to address.

WFSICCM Board Meeting, Budapest, September 2014
Image credit: WFSICCM

What are you looking forward to most at the WFSICCM Congress with its theme of "One Step Further: The Pursuit of Excellence in Critical Care"?

We can improve our systems, with better processes of care, better communication in the ICU, team approach, checklists etc. That is where most progress has been made.

How important are international collaborations in advancing intensive care science and practice, and what is an example of how they have changed clinical practice?

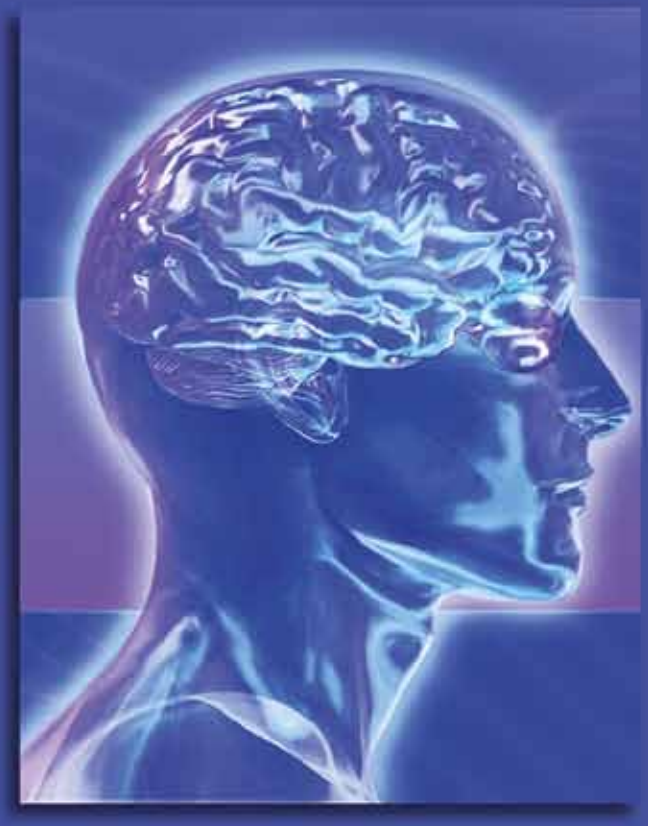
The ICON study has helped to identify some important ways to improve patient management. Just as an example, the analysis of transfusions has revealed that transfusions may be beneficial in the most severely ill – maybe we have become too restrictive with our transfusion! We are preparing other clinical trials, perhaps on fever control – these worldwide studies must be relatively simple, however.

What European and world collaborations does the WFSICCM engage in?

We have regular contact with the World Health Organization; they have not been much exposed to critically ill patients – they have discovered ICUs and are now happy to discuss with others. We are also now consulted by the European authorities.

This interview will appear in ICU Management's Summer issue, which has a cover story on "Cost-Effectiveness." Do you think there is enough understanding in the intensive care community about what is cost-effective?

The community understands it better and better… and sometimes too much! We have not been used to use costly therapies and are reluctant to the idea of using some – the activated protein C story is partly related to this. New drugs are costly and ICU doctors are not prepared for it! Oncologists do not have the same hesitations! Our interventions are not so costly especially in relative terms. As an example we used to say albumin administration is costly, but it is not so much in relation to all the other treatments patients receive today. ■



Join Us at our International Course

Brain Critical Care and Emergencies (BRACE)
with demonstrations

Erasme Hospital, Brussels, June 22-23, 2015

Goals:
The goal of this clinically-oriented meeting is to provide intellectual interaction with leading experts, to gather the essential information needed to treat neurological/neurosurgical patients, including those with traumatic brain injury, subarachnoid hemorrhage and intracranial hemorrhage.

Target:
Our target audience includes doctors working in ICUs or in emergency rooms, as well as neurosurgeons and neurologists who are interested in improving their understanding of the fundamentals of neuro-monitoring and management.

Course directors :
Fabio Taccone (Brussels, Belgium)
Jacques Creteur (Brussels, Belgium)
Jean-Louis Vincent (Brussels, Belgium)

Université Libre de Bruxelles
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Department of Intensive Care
Route de Lennik 808, B-1070 Brussels
www.intensive.org

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SMACC CHICAGO

Social Media and Critical Care (smacc)'s third meeting takes place in Chicago from 23-26 June. *ICU Management* spoke to one of the smacc founders, Dr. Roger Harris, to find out more.

What is the background to smacc?

Oliver Flower and I started our website **www.intensivecarenetwork.com**, and began collaborating with a similar site run by Chris Nickson and Mike Cadogan **www.lifeinthefastlane.com**. We began working with similar sites around the world and the movement FOAMed (Free Open Access Medical education) was born. Many of these sites were growing exponentially with > 50,000 page views per day. They shared a common ethos, which was that the education they produced was posted free for anyone to access. Some sites were blogs, others podcasts etc. We decided we would like to come together as a group and hold a physical meeting driven from the websites. Oliver Flower, Chris Nickson and I came up with the idea of smacc (as it represented our website origins and strong social media platforms spreading the education). We established a Not for Profit (NFP) charity, and the three of us seeded the meeting from our own pockets as a donation to the project. We expected 100 delegates and got 700 at the first meeting.

The smacc meeting has grown to over 2,500 delegates. What do you attribute this phenomenal growth to?

The meeting is different to anything else out there. One delegate wrote to say it was the first meeting she had been to for years (including all the big Australasian / North American and European meetings) where she came away feeling "inspired, proud to be a doctor and excited to take her knowledge back to work"!

The involvement of delegates starts well before the meeting. There have already been > 10000 tweets carrying the hashtag #smaccUS. There is no lectern (for speakers to rest on), and we discourage PowerPoint with complicated statistics etc. that are hard to read and distract from what the speaker is saying. Some find it hard to believe that you can give a high impact academic presentation on a critical care topic without showing all the evidence on PowerPoint – we would argue that the speaker should inspire the audience to think, go away and read the literature for themselves and then re-listen to the talk. I challenge any conventional speaker to watch the greats, such as Professor Simon Finfer, at smacc in Chicago and not agree.

Why is social media so important in critical care?

Social Media (SoMe) is important to all doctors. We present at many different meetings now as they all recognise that SoMe is a great way of communicating. It creates a conversation that can be held very rapidly. The journals recognise this, and many research studies now use SoMe as one of their means for disseminating information.

Smacc lists many affiliated websites in North America, Australasia and Europe. Are you hoping that low-income countries will be able to participate?

Any website that contributes to FOAM can get involved. The material from smacc is all podcast and released free on the Internet after the conference so that anyone can download the talks. Smacc has had 750,000 downloads of these talks from all over the world, many from developing nations. The big barrier is language. While many health professionals in developing countries speak English it is not their first language so this creates challenges. To this end we have been looking at getting the talks translated.

What innovative presentation methods do you use at smacc?

We plan our sessions with key educational objectives and then package that education in an inspiring interactive experience. Sonowars is a great example (see the video at **https://vimeo.com/74193257**) and you will understand. There are some great messages in that session (for instance about the movement of the myocardial septum in RV failure), which were delivered in an unforgettable theatrical style.

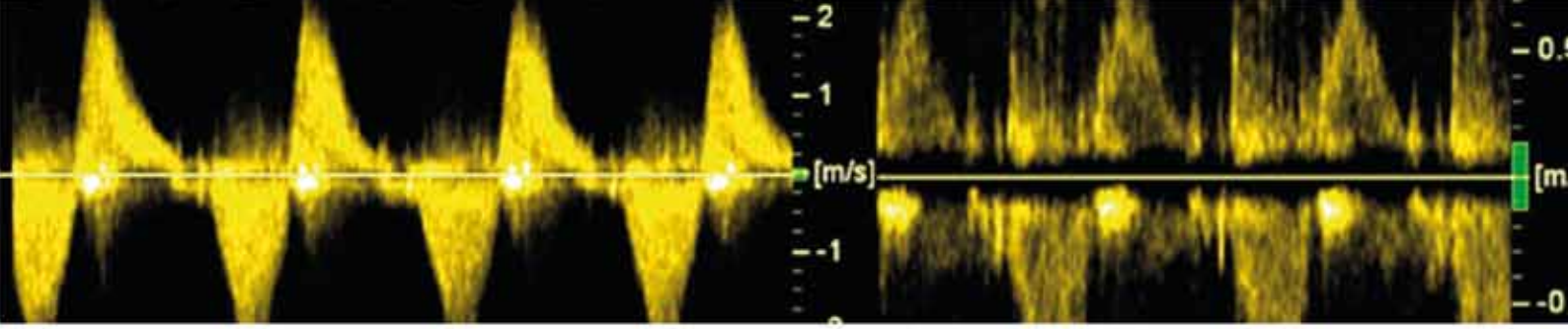
What are you looking forward to the most at smacc Chicago?

For me personally – it being over! We all contribute hundreds and thousands of hours on this project for free. The committee pays their own way…we do this because we believe passionately in FOAMed, but I think we will all be glad for a break in July. That said I can't wait to feel the buzz, the vibrant energy that smacc generates – it's electric and I haven't encountered anything like this in my 20 years of attending critical care conferences. ■

For further information visit
http://www.smacc.net.au/

Be part of SMACC on Twitter - Follow:

Roger Harris @RogerRdharris
Oliver Flower @OliFlower
Chris Nickson @precordialthump
The SMACC Team @smaccteam
and use the following hashtags:
#smaccUS
#FOAMed
#FOAMcc



13th International Course

Echocardiography for Hemodynamic Monitoring 2015

with videotransmissions of live cases from the ICU

Brussels, November 17-19, 2015

Course directors
Daniel De Backer (Brussels, Belgium)
Michel Slama (Amiens, France)
Antoine Vieillard-Baron (Boulogne-Billancourt, France)

Special faculty guests:
Paul Mayo (New York, USA)
Anthony McLean (Sydney, Australia)

Other Faculty members:
Yassine Mahjoub (Amiens, France)
Jan Poelaert (Brussels, Belgium)
Philippe Unger (Brussels, Belgium)

Organized by:
the Department of Intensive Care Medicine of Erasme Hospital.

Aim:
To promote the use of echocardiography in the hemodynamic evaluation of critically ill patients.

General description:
The course, will be interactive, with a lot of time devoted to questions, hands-on sessions, and discussions of live video-transmissions.

The first day will be devoted to revising the basics of echocardiography; the second and third days will describe how to use this technique to evaluate the hemodynamic status of critically ill patient.

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Department of Intensive Care
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Hôpital Erasme

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AGENDA

JUNE

23-26
SMACC Chicago
Social Media and Critical Care
Chicago, USA
www.smacc.net.au

24-26
SESAM 2015
Belfast, Ireland
www.sesambelfast2015.com

JULY

8-12
ISCCM: 3rd Annual International Best of Brussels Symposium on Intensive Care and Emergency Medicine
Pune, India
www.isccmpune.com

16-18
Paediatric Continuous Renal Replacement Therapy
London, UK
www.pcrrtconferences.com

AUGUST

14-16
Annual Scientific Meeting on Intensive Care (ASMIC)
Kuala Lumpur, Malaysia
www.msic.org.my

29-1 September
12th Congress of the World Federation of Societies of Intensive and Critical Care Medicine
Seoul, Korea
www.wfsiccm2015.com

29-2 September
ESC Congress 2015
London, UK
www.escardio.org/ESC2015

SEPTEMBER

5-8
ESPEN
Lisbon, Portugal
www.espen.org/lisbon

7-8
5th International British Association of Critical Care Nurses Conference 2015
London, UK
www.baccnconference.org.uk

9-12
4th European Conference on Paediatric and Neonatal Cardiac Intensive Care
Montreux, Switzerland
www.epncic.com

14-16
29th Paediatric Intensive Care Society Conference 2015
Birmingham, UK
www.ukpics.org.uk

26-30
ERS International Congress
Amsterdam, Netherlands
www.erscongress.org

OCTOBER

3-7
28th ESICM LIVES 2015 Annual Congress
Berlin, Germany
www.esicm.org

10-14
EuSEM 2015 European Congress on Emergency Medicine
Torino, Italy
www.eusemcongress.org

IN OUR NEXT ISSUE

COVER STORY
The Brain

MANAGEMENT
20 Years of Benchmarking

MATRIX
Glycaemic Management

COUNTRY FOCUS
Canada

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

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