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Cost Effectiveness in Care

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PLUS:

- PCA INFUSION PUMPS
- CHANGE MANAGEMENT
- INTENSIVE CARE IN POLAND

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Editorial

Cost Effectiveness in Care

Quality of care has always been our primary goal as critical care professionals. We strive daily to find yet new methods and treatments to increase our effectiveness so that we save or improve as many lives as possible. However, there is always one drawback to quality that we have to overcome continuously. Whatever new and astounding technologies there might be, whatever novel treatments and drugs become available, there is always the restriction of budgeting and our goal is to make the best out of what we have in order to achieve the highest standards of care. With budgets always tighter, funding is becoming even harder to find. We in **ICU Management** recognise this ongoing struggle for the managers of critical care of meeting high costs while providing the finest quality care and we have devoted this issue to the subject of cost effectiveness.

In this issue of **ICU Management**, Dominique Vandijck and colleagues from the Intensive Care Department, University of Ghent describe the comprehensive management tool of Cost-Effectiveness Analysis when applied to the intensive care unit (ICU), whereby two clinical practices or new technologies can be compared in order for the most beneficial and cost-effective one to effectively be selected. Furthermore, Dr. Capuzzo compares costs of intermediary care units with those of ICUs, Dr. Csomos describes Diagnostic Related Group funding and its potential future for critical care, and Dominique Vandijck and colleagues conclude our *Cover Story* by an article on the economic impact of catheter-related bloodstream infections.

As usual, in this issue of your management and best practice journal, you will find a number of interesting and enlightening articles focused on management. Drs. Pauldine and Dorman introduce a series on the topic of change management in the ICU, headed by a recognition of the sources of and barriers to change in critical care. Dr. Claudio Ronco, a leading name in nephrology and intensive care, shares his knowledge and experience with **ICU Management**. We also look at Poland and its healthcare and intensive care systems. Do not miss the preview for this year's European Society of Intensive Care Medicine's annual congress, combined with the Society's "silver anniversary", in Berlin.

We are also glad to announce the launch of our new rubric *Forum*, which will provide a platform for continuous discussion of critical care practices, new products and technologies, and controversial issues. We begin with an article by Dr. Billiet, which was submitted as a response to a previous article that appeared in a 2005 issue of **ICU Management** – "Performance evaluation of European pressure sensors" by Dr. Cochard. For future articles under this heading, we will count on your experience, knowledge and research. If you feel that you can contribute to the critical care *Forum* created by **ICU Management**, please do not hesitate to contact our editorial team for support.

The world of critical care management is more dynamic than ever and we must learn to meet every new challenge that we are faced with. To provide better quality care while managing our budgets effectively, we need to learn and incorporate complex management techniques. Therefore, this issue of **ICU Management** will provide you with a glance over cost effectiveness in critical care and we hope that we can continue helping you in your struggle for quality.

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Letters to the Editor & Requests for References Cited in ICU Management
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News World

WHO Publishes Key Health Statistics

www.who.org

On 18th May, the World Health Organization (WHO) published *World health statistics 2007*, the most complete set of health statistics from its 193 Member States. This edition also highlights trends in ten of the most closely watched global health statistics. It is the annual reference for a set of 50 health indicators in countries around the world and is also available as an online database. It includes information on:

- How much money is currently spent on health in comparison to regional burdens of disease;
- Projected patterns of major causes of death for 2030;
- Gaps in reliable information, and how estimates of maternal mortality are made;
- he diseases that are killing people, and those that make them sick;
- The extent to which people can access treatment, the major risk factors for ill-health, the human resources underpinning health systems; and
- Health outcomes in the context of demographic and socioeconomic status of individual countries.

Dr. Margaret Chan, WHO Director-General, said "Reliable health data and statistics are the foundation of health policies, strategies, and evaluation and monitoring. Evidence is also the foundation for sound health information for the general public… I regard the generation and use of health information as the most urgent need."

New Initiative to Tackle Health Worker Migration

www.who.int/hrh

The Health Worker Migration Policy Initiative held its first meeting on 15th May at the World Health Organization's (WHO) headquarters in Geneva. It is aimed at finding practical solutions to the worsening problem of health worked migration from developing to developed countries. The initiative, convened and co-funded by the Global Health Workforce Alliance, is made up of two groups that will work closely together over the coming months to develop recommendations. The Migration Technical Working Group, which is being coordinated by WHO, brings together the International Organization for Migration, the International Labour Organization, professional associations, experts and academics.

A recent study (Connel et al. 2007) showed that the number of foreign-trained doctors has tripled in several OECD countries over the past three decades. The number of foreign-trained doctors from countries with chronic shortages of health workers is relatively small (less than 10% of the workforce) in developed countries. However, for some African countries, the migration of a few dozen doctors can mean losing more than 30% of their workforce, even as basic health needs remain unmet. Other health professions are also affected by this phenomenon. The study showed that from Swaziland, 60 to 80 nurses migrate to the UK each years, while fewer than 90 graduate from Swazi schools.

One of the initiative's first priorities will be to support WHO in drafting a framework for an International Code of Practice on Health Worker Migration, as called for by a resolution of the World Health Assembly in 2004. This framework will promote ethical recruitment, the protection of migrant health workers' rights and remedies for addressing the economic and social impact of health worker migration in developing countries. The Code of Practice will be the first of its kind on a global scale of migration. Ms. Mary Robinson, leader of the initiative, summarized the need for urgent action: "We cannot stand alone as individual countries continue to address their own increased needs for health workers without looking beyond their shores to the situation these migrating workers have left behind in their homelands. We cannot continue to shake our heads and bemoan the devastating brain drain from some of the neediest countries on the planet without forcing ourselves to search for – and actively promote – practical solutions that protect both the right of individuals to seek employment through migration and the right to health for all people."

News Industry

PULSION launches $PiCCO_2$

www.pulsion.com

At the International Symposium on Intensive Care and Emergency Medicine (ISICEM) in March this year, PULSION presented their new product $PiCCO_2$, the first product of a new generation in hemodynamic monitoring. $PiCCO_2$ provides its users with a general overview, as well as detailed insights into the different aspects of the cardio-vascular system through a combination of technologies. Its functions include continuous central venous oxigenation monitoring, volume management, bedside assessment of pulmonary edema, and others, thus aiding the attending physician in making fast and accurate diagnoses and better therapeutic decisions. $PiCCO_2$ is an instrument designed to support the hemodynamic therapy of acute critically ill patients, where optimal oxygenation of the organism is among the principal goals. It is built to meet the need in critical care for early recognition of supply deficiencies and for accurate diagnosis. Bradley Gould, CEO of PULSION Medical Systems AG, said: "We wanted to make a product available to doctors and nursing staff which would, through ease of use, provide maximum support for making time sensitive decisisons. The feedback from the public for our groundbreaking new product was overwhelming and I believe that we are hereby also ready for the competition in the US market."

Largest Study on Stroke and Fabry Disease (SIFAP)

At the "Stroke in Young Fabry Patients" conference, which took place in Berlin, in February 2007, the largest study on the causes of stroke in young patients up to date, SIFAP, was launched. The main focus of the study is Fabry Disease – one of the possible causes of this type of stroke. In the first step (SIFAP1), a total of 5,000 young stroke patients at over 30 European centres are going to be thoroughly examined for risk factors. After 18 months, SIFAP will allow conclusions to be drawn about the exact prevalence of Fabry Disease in young stroke patients. Up to 100 so far unrecognised Fabry patients are expected to be identified. As a part of a follow-up study (SIFAP 2), patients diagnosed with Fabry Disease are going to be monitored for 3.5 years and during this period, the effectiveness of prophylactic and therapeutic measures are going to be closely analysed. SIFAP is aimed at addressing physician's current understanding of this rare lysosomal storage disorder and existing treatments.

ARROWg+ard antimicrobial catheter technology: new generation now available in Europe

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On October 1st, 2006 Arrow International received CE mark clearance for its ARROWg+ard Blue PLUS new catheter generation with Chlorhexidine along the entire intraluminal path and increased levels of Chlorhexidine on the catheter's external surface for better protection. Chlorhexidine-silver sulfadiazine is a CDC level 1B recommendation for the prevention of infection, for implementation and is supported by experimental, clinical and epidemiological studies.

Cost-effectiveness analysis in critical care

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Critical care medicine is becoming more and more costly. To keep it viable, a cooperative atmosphere must be created among all healthcare stakeholders in order to manage this economic issue without compromising quality or access to critical care services. Cost-effectiveness analysis (CEA) may be the key management tool for aiding decision-making concerning the allocation of scarce healthcare resources.

Introduction

Through the development of new therapeutic and diagnostic techniques, the greying of the population and the changing profile of the ICU patient, the demand for acute and high-tech care is increasing (Vandijck et al. 2006). As a consequence, critical care medicine places a heavy weight on the healthcare budget. With only 5-10% of the total beds, the ICU now accounts for about a quarter to almost one third of total hospital costs (Halpern et al. 2004). Applying economic tools to control the exponential growth of healthcare resources use has become increasingly important. CEA may help us understand the consequences of new interventions available for critical care.

What is CEA?

CEA is an economic evaluation technique designed to compare the costs and benefits of one healthcare intervention with those of an alternative solution. In its most common form, CEA compares a new strategy with current practice and the result is expressed as a ratio (fig. 1) (Gold et al. 1996).

$$\text{Cost-effectiveness ratio} = \frac{\text{Cost}_{\text{new strategy}} - \text{Cost}_{\text{current practice}}}{\text{Effect}_{\text{new strategy}} - \text{Effect}_{\text{current practice}}}$$

Figure 1: Cost-effectiveness ratio

The core aim of CEA is to assess whether the new therapy is worth implementing, relative to the resources available. In other words, CEA analyses the cost to achieve the desired effect of a therapy (expressed as life-years or symptom-free days gained) (2002). Economic effects can also be described in terms of quality of life, expressed in quality-adjusted life years (QALYs) (Haentjens and Annemans, 2003). The cost savings due to an intervention are taken into account in the numerator of the cost-effectiveness ratio. The difference between the costs of the new and the current strategies is called a "net cost". If it is negative then the new strategy would lead to a net cost saving.

In CEA, it is conventional to distinguish between "direct costs" (e.g. personnel time, drugs, laboratory tests, increased hospital stay), "indirect costs" (e.g. production losses, families' time) and the so-called "intangibles" (e.g. pain, complications, discomfort, suffering) (Russell et al. 1996). The latter may be difficult to quantify. However, from an economic point of view, intangibles should also be included in the final cost estimate (Jarvis 1996). To ensure appropriate interpretation, it is essential to specify which costs were taken into account in the CEA.

How to interpret CEA?

Although not expressed in monetary terms, a CEA ratio might be considered as 'the price' of the additional benefit of a new practice. Different scenarios are possible, as shown in figure 2. Most new and effective interventions are not cost-effective because of their high price (quadrant Ia). However, if their price is not much higher than that of the current practice, then it could be considered cost-effective (quadrant Ib). Ideally, the new strategy would be more advantageous

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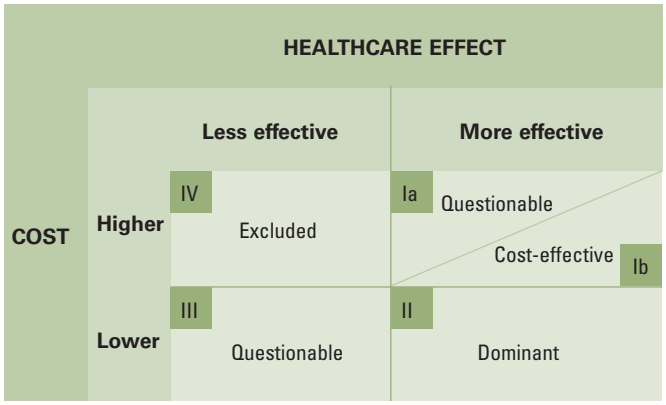

Figure 2: Graphic illustration of CEA interpretation

Costs of intermediate care and intensive care

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Intermediate care units (IMCUs) are suitable for patients needing a level of care lower than Intensive Care Unit (ICU) but higher than ward (Zimmerman et al. 1996; Vincent and Burchardi, 1999). Accordingly, IMCUs can act both as step-up units for deteriorating and step-down units for improving patients. IMCUs have been recommended to reduce post-ICU mortality (Smith et al. 1999; Beck et al. 2002), to facilitate earlier ICU discharges (Bone, 1993; Weissman, 2000), to limit the cost of staffing, and to optimise ICU resource utilisation (Arabi Y et al. 2004; Iapichino et al. 2005).

The costs can be grouped into patient-related (incl. staff, consumables and clinical support) and non-patient-related (incl. capital equipment, estates and non-clinical support) (Edbrooke et al, 1999). Staff cost is the strongest determinant of total costs while nursing staff has been reported responsible for more than 50% of the ICU costs. Therefore, if the patients admitted to the IMCU need a lower intensity of treatment than intensive care by definition, the nurse-to-patient ratio in the IMCU can be lower than in the ICU: a nurse-to-patient ratio of 1:3 or 1:4 has been proposed for IMCUs (Zimmerman et al. 1996), while ICU nurse-to-patient ratio ranges from 1:1 to 1:2 in Continental Europe (Miranda and Nap, 2001). As a consequence, daily costs of IMCUs are lower than those of ICUs but higher than wards'.

However, both the IMCU and the ICU are just parts of the hospital, sharing the same final objectives - to allow patients to recover their health at the lowest cost possible. Therefore, the main economic issue is not the daily cost of stay in the ICU or in the IMCU, but the patient's total hospital cost. Therefore, to stay in the IMCU is cheaper than in the ICU only if the patient spends in the IMCU some of the time he/she could have spent in the ICU. Thus, IMCU length of stay should be carefully considered in the analysis of costs.

Despite the high number of studies suggesting the effectiveness of IMCUs, only few analysed existing units. Junker et al (2002), who considered 5,116 ICU low-risk monitor and 8,971 IMCU patients, found differences in age, type of patients, and severity of illness. In comparison to ICU, IMCU patients showed higher mortality rate (3.1% vs. 2.3%), higher incidence of readmissions (5% vs. 4%), and longer length of stay (2.6 ± 2.2 days vs. 3.9 ± 3.1 days). The nursing Whole Time Equivalent per one patient staying for 3.9 days in an IMCU with nurse-to-patient ratio of 1:3 is the same as that per one patient staying 2.6 days in an ICU with nurse-to-patient ratio of 1:2, provided that the ICU and the IMCU have the same occupancy.

Others studied the effect of adding an IMCU. Abizanda et al (2005) found that the IMCU patients of a new, 4-bed, step-down unit were older and less seriously ill than those in the ICU. No change in hospital mortality ratio was noticed, but post-IMCU hospital mortality and IMCU length of stay increased. Eachempati et al (2004) studied the effect of the change in a surgical department from a 9-bed ICU to a 10-bed ICU + 4-bed IMCU. The mean APACHE II of the whole group of patients was higher in the second period (14.2 vs. 13.4). The mortality showed a trend towards a decrease from 8.7% to 6.0%, but the general length of stay in the unit increased from 3.8 to 4.3 days.

Consumables and clinical support costs were also analysed using a bottom-up approach in a sample of 60 ICU and 65 Respiratory IMCU patients admit-

"...both the IMCU and the ICU are just parts of the hospital, sharing the same final objectives - to allow patients to recover their health at the lowest cost possible."

ted with acute exacerbation of Chronic Obstructive Pulmonary Disease (Bertolini et al. 2005). Total consumables and clinical support cost per patient in the Respiratory IMCUs amounted to approximately half of that in the ICUs, while median length of stay was 7 days in ICU and 8 days in Respiratory IMCU. Nevertheless, it has been demonstrated that the cost of treatment varies according to diagnostic category and severity of illness (Rossi et al. 2006).

Furthermore, any preliminary analysis of a new IMCU has to consider provisional number of beds and bed occupancy, as well as logistical link with the ICU. When the IMCU is integrated in the ICU, its minimum number of beds depends on the nurse-to-patient ratio required, usually 1:3. Otherwise, it cannot be lower than a multiple of the nurse-to-patient ratio, being at least 1:6. Situations such as sudden deterioration of patients need to be considered. If the IMCU and the ICU are physically jointed, one nurse is sufficient for the intermediate care because ICU nurses can provide help when needed, guaranteeing the safety of the patients. If the IMCU is not integrated (e.g. being next to an operating room, which is closed at night), one nurse in the unit is not enough: if a patient's condition suddenly worsens the nurse alone cannot manage the critical patient, call for a doctor and take care of other patients. In such cases, patient safety is not guaranteed. Furthermore, a study showed that 5% of the 1,092 bed-days surveyed in a surgical ward were occupied by patients needing a higher level of care (Coggins RP, 2000). Nevertheless, a 3-bed IMCU, integrated in the ICU, would provide a number of bed-days double the required.

In conclusion, the cost of staffing, which is the most relevant part of total costs, is lower in IMCUs than in ICUs. Moreover, bed capacity and length of stay are the major determinants of unit throughput, so predictions made before any change in bed availability should be compared with occupancy rate and length of stay observed after the change. In fact, healthcare systems are flexible and can adapt to multiple external constraints, maintaining a natural disposition to growth. ■

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and lower-priced (quadrant II). In the worst case, it should be excluded (quadrant IV). A third-quadrant situation implies that the new practice is less beneficial than the current one, therefore its value is questionable.

Being cost-effective according to CEA does not mean the new strategy will necessarily save money. There are additional factors such as personal and social value, governmental priorities, ethical dilemmas and so on that may also influence one's interpretation of the analysis.

Critical care and cost-effectiveness analysis

In a recent review article by Talmor and co-workers, the authors gave an overview of well-conducted CEA studies in critical care medicine (Talmor et al. 2006). As this topic is still emerging within the field, only 19 studies directly related to the management of the critically ill and reporting cost per QALY, were found and considered for further investigation. Although measuring cost-effectiveness is not clear-cut, there seems to be an international consensus that interventions with a CEA ratio of approximately €50,000 per QALY or lower are acceptable. Some CEA studies in critical care report either extremely high or very low CEA ratios (≥€200,000 vs. ≤€10,000 per QALY, respectively). However, most fall somewhere in-between.

Conclusion

Critical care medicine is expensive, and this trend will not be curbed soon. For all healthcare players involved, it is of the utmost importance to allocate the available resources as appropriately as possible. CEA may be therefore a valuable tool to support the decision-making process in critical care medicine. ■

Diagnosis Related Group (DRG) funding for intensive care

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Diagnosis Related Group (DRG) is by definition, a case mix classification scheme, which was designed in the 1960s to evaluate hospital performance. It was then adopted some 20 years later as a base unit of payment in the Medicare system in the United States (Inglehart, 1983). There were 467 DRG categories in its original form and these were defined by diagnosis, procedure and patient age information from a nationally representative sample of discharge records. Groups were intended to be clinically similar and to require similar amounts of hospital resources. To construct a hospital-specific index, the frequency of cases in each DRG was multiplied by a cost weight. These weights were constructed by converting the mean charge per DRG to cost. In theory, as it can be found in the report to the Congress (Schweiker, 1983), "hospitals can keep any surpluses they achieve, […] physicians can be expected to compete with each other for available resources," and the authors also hoped that "cost-ineffective practice patterns will be discouraged".

Has the DRG funding proven its advantages over the years? No, it has not. That is why there are no countries in Europe at present, which use solely DRG funding for intensive care. The major inaccuracies were highlighted even after its introduction in 1983, as the President of the Association of American Medical Colleges was left with three major concerns (Inglehart, 1983):

1. Lack of sensitivity of the DRGs in measuring differences between patients;
2. Inaccuracies resulting from the use of average cost and average prices;
3. Appropriate recognition of and payment for teaching hospitals.

Why don't we want to use DRGs alone in intensive care? Let's just discuss the three "ageing" basic concerns outlined above. First, DRGs are designed for acute inpatient hospital care and the purpose is to group those patients who are similar clinically and who have a similar pattern of resource use. A large number of DRGs, however, do not describe resource use well and the average cost of treating a patient in any given DRG is higher for hospitals with than for hospitals without ICUs (Cooper and Linde-Zwirble, 2004). Second, the average price for the average patient does not exist in the ICU; there are outliers, who cost disproportionably more than average. The study by Cooper (2004) shows this in a large database, involving 55.8% of all intensive care unit days for one year in the USA (Table 1)(Cooper and Linde-Zwirble, 2004).

Finally, teaching hospitals are expensive places to treat patients. The higher cost of care has been attributed to a more complex case mix, the use of more sophisticated technology and the "legitimate" extra cost of teaching, which is not taken into account by DRG (Aardal et al. 2005).

Can the DRG funding be improved? Yes, it is possible to make it better by several different methods, including:

- Entering correct medical records. In a Norwegian study, the quality of medical records was checked in the authors' ICU (Neilson et al. 2004). They performed a retrospective analysis of submitted DRG codes in a year and found that an additional 18.4% DRG points could be retrieved, which corresponds to €1.1 million!
- Identifying the outliers. It is well known that extended length of stay (LOS) significantly contributes to the ICU costs (Neilson et al. 2004). In order to improve DRG, we should try to identify the factors, which can predict prolonged LOS in the ICU. Higgins et al (2003) analysed 12 variables against weighted LOS (n= 10,862) and found that mechanical ventilation and presence of infection on admission prolongs LOS.
- Taking into account other high cost drivers such as direct nursing hours, number of organ failures, expensive medications, certain procedures, etc. This will encourage us to concentrate on the individual differences between ICUs, which an ideal funding system should also take into account. Of course, this can only be done if detailed costing data is available.

What is the future of DRG in intensive care? DRG funding will only work if country-specific adjustments are made, depending on the structure of the healthcare system and the intensive care settings. In France, for example, DRG is combined with the activity-driven funding. This incurs additional funding for procedures performed in the ICU (Guidet et al. 2006). In Germany, however, a simplified Therapeutic Intervention Scoring System (TISS-28) is used for ICU funding in combination with DRG (Neilson et al. 2004).The continuing demand for intensive care combined with limited budget for healthcare expenditures will motivate us further to look for the ideal funding of intensive care. ■

Year 2000	ICU	CCU	Floor
Discharges (No.)	2,353,208	934,459	7,369,920
Outliers (%)	10.4	5.1	1.3
Overall profit (loss)	(5.8 B) US$	(1.2 B) US$	2.0 B US$

Table 1.

Economic impact of catheter-related bloodstream infections

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Healthcare-associated infections affect approximately 7-10% of hospitalised patients (Haley et al. 1985). Particularly in the intensive care unit (ICU), patients are, due to their critical condition, more prone to develop such infections (Vandijck, 2006). Of these, catheter-related bloodstream infections (CR-BSIs) compse the third most frequently observed category (Vincent et al. 1995). Accordingly, the clinical and socio-economic impact (e.g. increased morbidity, mortality and costs) adversely affects patients and communities' well-being (Jarvis, 1996).

Salient literature investigating the specific aetiology and clinical outcome of ICU-acquired CR-BSIs is available. However, few studies attempted to estimate those infections' impact on the healthcare budget. When trying to determine CR-BSIs associated costs, a distinction has to be made between direct and indirect costs. The direct costs include longer hospitalisation, staff time, drug treatment and laboratory cultures. Indirect costs are represented by the patients' lost remuneration, loss of productivity on the labour market, relatives' time, and infirmity. For the United States alone, sepsis is accounting for 40% of total healthcare expenditures and costing up to $16.7 billion annually (Halpern et al. 2004). Out of this figure, CR-BSIs are estimated to be responsible for $957,680,000 (Cosgrove, 2006; O'Grady et al. 2002).

Recently, Warren et al (2006) performed a study concerning the effect of CR-BSIs in a cohort of ICU patients of a non-teaching hospital. In this population, no increased risk of death was demonstrated when the patients' course was complicated by a CR-BSI, but the attributable increase in total hospital cost was $11,971, and in ICU and hospital length of stay, it was 2.4 and 7.5 days, respectively. These results were further confirmed by others in teaching ICU settings. A study of our group, which took place between 1992 and 2002, showed an increased stay in the ICU and hospital of 8 and 12 days respectively, and increased total hospital costs of €13,585 (Blot et al. 2005). DiGiovini and colleagues evaluated the effect of primary CR-BSIs and also found a significant rise in costs and length of stay (Digiovine et al. 1999). Rello et al (2000) and Dimick et al (2001) reported similar findings. The study by Laupland et al (2006) supports these previous results, but also reported that ICU patients who develop a CR-BSI suffer excess morbidity and mortality.

In the updated recommendations regarding CR-BSI prevention, the Centers for Disease Control and Prevention (CDC) argue that teaching process-measure controls and enforcing standards can have a remarkable impact on this preventable infection (O'Grady et al. 2002). The primary aim should be to increase ICU staff awareness, to reduce complexity, to avoid routinely and non-indicated use of intravascular catheters, and to empower all healthcare providers to enforce adherence to evidence-based infection control practices, as well as to ensure that patients receive the therapies they ought to (Berenholtz et al. 2004). However, to enhance the success of such an 'improvement model' and to increase the credibility and visibility of this initiative, it is of utmost importance to have full multidisciplinary commitment of managerial board, physicians, nurses and infectious diseases practitioners.

Three Latin American studies (Higuera et al. 2005; Lobo et al. 2005; Rosenthal et al. 2003) reported a drop of infection rates and substantial reduction of hospital stay after employing low-cost strategies in compliance with the CDC guidelines. In developed countries, these low-tech measures have also been shown successful in reducing total catheter days (Pronovost et al. 2006; Warren et al. 2004). In an extraordinary study by Berenholtz et al (2004), five interventions were implemented: educating the staff concerning standard prevention measures that should be taken into account when inserting or taking care of IV devices; assembling a protocol cart for the house staff; asking staff daily whether catheters could be removed; introduction of a checklist on adherence to evidence-based recommendations; and empowerment of nurses to stop any procedure when in violation with guidelines. CR-BSIs rates were significantly reduced and the authors estimated that in their ICU alone, additional costs of about $2,000,000 were prevented by applying these simple strategies. Other low-cost ways to educate in effective practices for the prevention of CR-BSIs include mandatory self-study modules, scheduled meetings, training sessions, information leaflets and posters directed to the ICU staff.

In critically ill patients, CR-BSIs are associated with a significant clinical and financial burden, emphasising the importance of prevention measures. With fewer novel antibiotics in the pipeline, continuous implementation of low-cost and easy to organise strategies, such as educational programmes, may contribute to decreasing CR-BSI rates and consequently to lowering healthcare expenditures. ■

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Forum is the new rubric of ICU Management providing a discussion platform for critical care practitioners.

The following article is a response to Dr. Cochard's "Performance evaluation of European pressure sensors." (Issue 3, 2005 of **ICU Management**).

Introduction

Reliable diagnosis and therapeutic interventions on critically ill patients require accurately measured hemodynamic parameters. Invasive blood pressure measurement is still based on the pressure signal transmission within fluid-filled catheter-manometer system (CMS), which should be accurate within the bandwidth range of the blood pressure signal (0 to 12 Hz for adults and 0 to 30 Hz for neonates). With this paper we will describe the accuracy test method by means of the square wave test (SQT), the swept frequency sine wave test (SFT) and the patient signal simulation test (PST), and for each of them the performance of the major European disposable transducers will been shown (Van Gerdingen et al. 1994, Billiet and Colardyn, 1998).

Materials

- Biotek Model 601A. Pressure generator.
- HP 35660A Analyser. Bandwidth: 0.1 to 51,200 Hz.
- Analog Devices Amplifier. Bandwidth: 0 to 15,000 Hz.
- GE PDCR 35/D reference transducer. Bandwidth: 0 to 5,000 Hz.

Tested transducers

- Becton Dickinson DT- XX
- Braun Combitrans
- Edwards PX600F
- Medex LogiCal (MX960) and Transtar (MX950)
- Pulsion PV8015

Test principles

The Swept Frequency Sine Wave Test (SFT).
The SFT results in the total dynamic response of a DUT. A sine wave with a constant amplitude but swept frequency is applied to the input, and the output amplitude is measured for each corresponding frequency value showing the ratio of the output amplitude to the input amplitude within the bandwidth of interest. The frequency value, at which the amplitude ratio reaches its maximum, is called the resonance frequency F_R.

The Square Wave Test (SQT).
The SQT results in a limited characterisation of the DUT. When a pure square wave is presented at the input then the output will show a damped oscillation (fig 2). As a result, one can only calculate the oscillation frequency F_o and damping coefficient ζ as a discrete parameter of the total characterisation.

A Biotek 601A can generate a steep and repetitive step signal, but a flush device cannot. Unfortunately and mistakenly, the Gardner laboratory SQT (Gardner, 1981) employed the clinical fast flush device test as an easy tool to evaluate the in-vivo CMS, which can lead to hazardous interpretations (Billiet and Colardyn, 1992).

Figure 1: Materials and tested transducers

The patient signal simulation test (PST).

With all of the transducers simultaneously connected to the Biotek 601A, we simulated the radial artery patient signal and registered the resulting waveforms on a patient monitor.

Test results

In Table 1, the tested transducers are not referenced by brand or type as each of them perform superbly within the bandwidth of 0 to 30 Hz and a ranking would be incorrect and misleading.

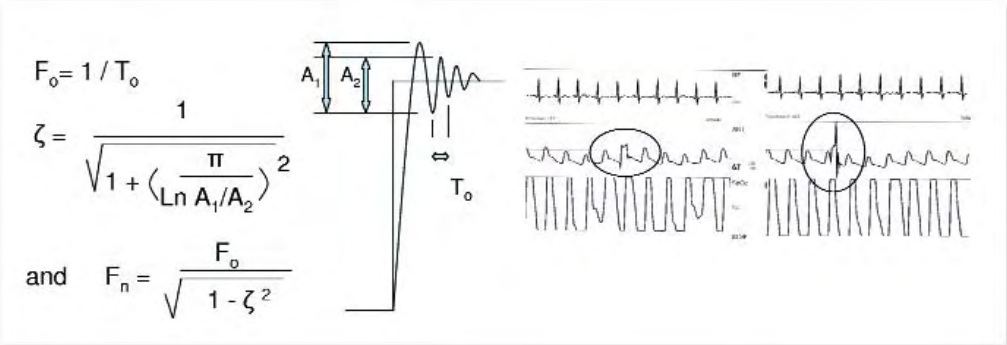

Figure 2: Step wave test – test principle and formulas. (Left: The applicable formulas on a step generated with Biotek 601A shown on the HP 35660 A with a 150 ms timeframe. Right: A step generated with a flush device shown on a patient monitor screen with a typical 8 sec timeframe. Depending on the activation of the flush compartment, a different oscillation will occur, and thus not useful for evaluation.

Conclusion

Despite other published results such as Performance Evaluation of European Pressure Sensors by J-F Cochard, which appeared in ICU Management, Issue 3, 2005, the high quality of each of the tested transducers is unarguably proven, which reveals that the major European devices show a perfect response characteristic indicating no distortion within the bandwidth of 0 to 30 Hz. Other test results will be obtained when adding pressure lines, stopcocks, catheters and patient monitors (Billiet and Colardyn, 1998). It is strongly discouraged to use the fast flush test to evaluate the accuracy of a CMS system when already installed on the patient. ■

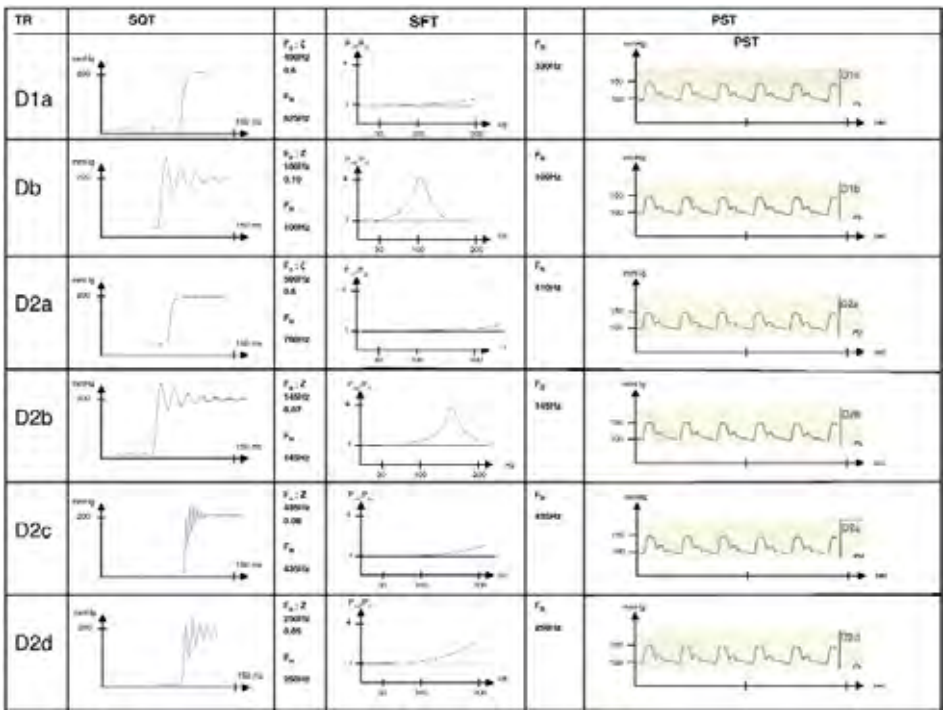

Table 1: Test Results

Genetic variation in the critical care setting

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ICU Stakeholder
- Anaesthesiology
- Cardiology
- Pharmacy
- **Genetics**
- Microbiology
- Nephrology
- Respiratory
- ...

Pharmacogenetics has made significant progress in recent years. Advances in pharmacogenetics and information technology will benefit critical care patients most of all.

General introduction to pharmacogenetics

An intersection of the disciplines pharmacology and genetics produces "pharmacogenetics." The term is not a new one. Pharmacogenetics first appeared in the medical literature in the early 1950s. But the ability to apply knowledge of the role of individual genetic variation into the treatment of disease with medications is new. This new diagnostic ability comes from three major technological advances: advanced genomic analytics, the world HIV epidemic and the digitizing of health records.

The Human Genome Project was the late 20th century's equivalent to the space race of the mid-20th century, in that a focused scientific effort towards a single goal drove the development of more and more advanced technology. Prior to the Human Genome Project, clinical genetic testing was slow, labor intensive and, as a result, expensive. Even though there is an extensive body of literature on the role of genetic variation in the pharmacokinetics and pharmacodynamics of xenobiotic compounds, applying that knowledge in the clinic wasn't previously, for the most part, practical. But we have now realized clinical genetic testing at speeds and costs that make this sort of testing comparable to other one-time diagnostics tests, generally in the $100-$800 range, with prices dropping as testing becomes more common.

The HIV/AIDS epidemic resulted in enormous advances in the way genetic testing results are reported. With the realization that viral genetics could be used to rescue patients from failed highly active anti-retroviral therapy (HAART) regimens, viral genetics became an important laboratory test. But expecting physicians, even infectious disease specialists, to be able to derive a therapy choice from a viral genetic sequence was unrealistic. Therefore, over a 10-year period, we progressed from a written genotyping report with a collection of nucleotides on it, to the current red, yellow, green reports that are generated electronically. Concurrently, there was a movement to provide the best possible interpretation of the test results through consensus and phenotyping. The lessons learned from these experiences in HIV/AIDS reporting are being directly applied to pharmacogenetics.

Although we can now test and report a useful result, given complete information, applying the test result to a single patient is a complicated process, in many cases. Truly personalized medicine requires the use of many different kinds of information, including age, gender, height, weight and concomitant conditions and medications. Also, liver and kidney function must be considered for many dosing decisions. While the patient's genomic sequence is invariant, the interpretation of that genotype may be of little or of great importance at any given time. But as with HIV, expecting physicians to be able to make the leap from a genetic sequence to a therapy choice is unrealistic in many cases. Fortunately, many of the variables needed for dosing algorithms are available in an electronic medical record. Therefore, with some fairly basic programming, that information can be put together to provide a test result reflecting the current status of the patient.

Now that the information is available, there is an urgent need to adapt this new technology to improve care and reduce healthcare costs. This is driving another merger of fields, similar to the merger of pharmacology and genetics: this merger is of

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Clinical Condition	Genes of Interest
Asthma	Type 2 beta adrenergic receptor (ADRB2)
Sepsis	Tumor necrosis factor alpha (TNFa)
Infectious Disease	Organism genotyping
Coagulation	Cytochrome P450 2 family C9 (CYP2C9), Prothrombin (F2), Factor 5 Leiden variation (F5L), 5,10-methylenetetrahydrofolate reductase (MTHFR)
Glycemic Control	Peroxisome proliferator-activated receptors (PPAR)
Seizure Control	CYP2C9, UDP glucuronosyltransferase 1 family, Polypeptide A4(UGT1A4)
Inflammation	C-reactive protein (CRP), Tumor necrosis factor receptor (TNFR)

Table 1: Most Useful Genes for Critical Care

Recommendations for medication errors prevention

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Drugs that are used in intensive care settings are numerous and often have narrow therapeutic margins. Patients have severe conditions that evolve quickly and require frequent adaptation of treatments. In such a dynamic and complex environment, medication errors are admittedly common and, given the low physiological reserves of patients, have therefore potential critical consequences. However, incidence figures are somewhat puzzling. According to a recent review of the available literature (Kane-Gill and Weber, 2006), the frequency of medication errors varies from 1.2 to 947 per 100 patient-days. When the number of administrations is used as denominator, large variations still remain, the frequency of medication errors being in the range of 3.3 10^{-2} and 4.4 10^{-1}. (Tissot et al. 1999; Calabrese et al. 2001; van den Bemt et al. 2002). Unfortunately, given the large differences in actual medication processes and evaluation methodologies, it is unlikely that more accurate figures that could be generalised to various types of settings would be available soon.

Whatever the true figures, one has to consider that such high rates characterise unreliable processes and would require immediate corrective actions in other areas (Leape, 1994; Garnerin, 2007). Therefore, in order to guide prevention strategies, we present a model eliciting the various ways in which the medication process can fail during drug preparation or administration. On the basis of this model and despite the lack of strong scientific evidence, recommendations for error prevention are suggested.

Modelling medication errors

The model is based on an event tree (IEC, 1990) which combines the different human errors leading to medication errors using AND and OR logical gates (Fig. 1). In this model, medication errors are the result of either preparation errors (incl. wrong drug, dilution and labelling errors) or administration errors (syringe swap, route, amount/flow, time patient errors).

Prevention of drug, syringe swap and route errors

The model materialises that wrong drug errors, syringe swap errors and wrong route errors are the result of both a selection error and a check failure. Consequently, prevention strategies should be based both on limiting opportunities for mixing-up drugs, syringes or injection lines and on increasing check reliability. A five-fold decrease in the probability of selection errors associated with a five-fold decrease in the probability of check failures will result in a 25-fold decrease in the risk of wrong-drug, syringe swap or wrong route errors.

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ICU Stakeholder
- Anaesthesiology
- Cardiology
- **Pharmacology**
- Genetics
- Microbiology
- Nephrology
- Respiratory
- ...

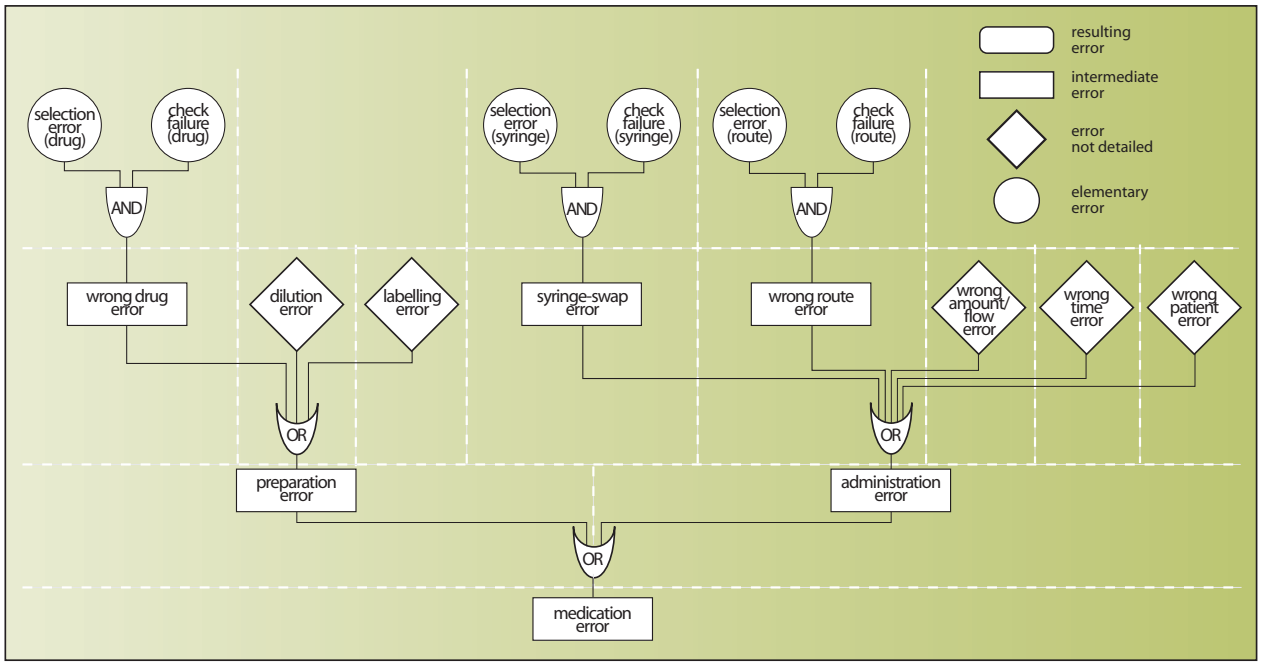

Figure 1: Medication error model

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Dose-finding and optimisation designs

ICU Stakeholder

- Anaesthesiology
- Cardiology
- **Pharmacology**
- Genetics
- Microbiology
- Nephrology
- Respiratory
- ...

Introduction

Knowledge of the issues related to clinical research is a requirement to the fuller understanding of the practice of evidence-based medicine (Columb et al. 2003). The prospective double-blind randomised controlled trial is essentially the gold standard for research methodology. Usually, these designs compare fixed levels of one or more variables and different outcomes. However, in dose-finding studies, there are often numerous doses, drugs and combinations to be investigated. Decisions on which combinations are most useful from the plethora of diagnostic tests and biomarkers are related problems (Fischer et al. 2003). Clinical research is driven to identify advantageous mixtures of drugs, to reduce side effects and to possibly identify synergistic combinations. In this article, we briefly consider two methods that have been appearing in recent literature in the setting of dose-finding: *Up-Down* and *Direct-Search* designs.

Up-Down Designs

These, sometimes called *threshold* or *sensitivity* tests, were promoted by Dixon in the 1960s and are used to concentrate testing about a particular response probability, usually the median effective dose (ED50) in efficacy or lethal dose (LD50) in toxicity trials (Dixon, 1965). The dose used varies up or down based on the outcome of the previous test. Testing gets concentrated around the eventual ED50. If, for example, we try to ascertain the LD50 of a drug (this is an easy example as the outcome of death is clearly a finite one) then the up-down method provides a point estimate of the LD50 and does this rather efficiently for many chemicals by only using six or seven animals (NICEATM, 2000). These methods have been used to estimate minimum alveolar concentration (MAC) for inhalational anaesthesia, minimum infusion rate (MIR) for intravenous anaesthetics, minimum local analgesic concentration (MLAC) for local anaesthetic agents and ED50 for vasopressors. The ED50 is analogous to measures of the central tendency of distributions, such as mean and median. As such, these are estimated with better precision compared to extreme values like the ED95. Therefore, tests of hypotheses using ED50 will have more power to detect differences if these exist.

As testing is concentrated around the eventual ED50, a number of issues follow with regard to the slope of the dose-response curve, ED95 and random versus sequential allocation. It has been suggested (D'Angelo and James, 1999; Columb and D'Angelo, 2006), that, because dosing is centred at ED50, there is little information regarding the slope of the dose-response relationship. In fact, testing at one standard deviation above and below the ED50 corresponds to the ED16 and ED84 point estimates, which essentially are the limits of the most linear part of the cumulative dose-response plot. So in effect, up-down designs actually concentrate testing where the slope is most defined. Errors in testing at extreme values (such as at or above ED95) receive more weight in usual regression analyses, which then are more likely to lead to incorrect estimates of slope. In addition, a pharmacological maxim that *drugs, which act via the same receptor or mechanism have parallel dose-response curves,* suggests that knowledge of the entire distribution is not absolutely required to make inferences. Therefore, drugs with differing slopes generally act by different mechanisms and are usually chemically distinct and from different classes! Since pharmacological potency is defined as *the measure of the dilution in which the drug is effective, characterised by the inverse of EC50 (molar)*, then we can state that drugs with different EC50 values have different potencies. This being the case, they do not occupy the same dose-response distribution and, by definition, are not *bioequivalent*. By design, doses are sequentially allocated in up-down studies, not randomised. A possible bias may occur in study of a single sequence when there have been a series of effective or ineffective doses. The longer the series, the greater is the likelihood and expectation of a reversal! In this instance, the researcher may consider running two or more simultaneous sequences such that any subject can be randomised to a particular sequence and the data then can later be pooled for analysis. This improvement allows the design to achieve randomisation, which is more robust and closer to the gold standard design.

Direct-Search or Optimisation Designs

This is again essentially a progressive design, but comparing multiple drugs and doses simultaneously. The fundamental problem with finding optimal combinations is dimensionality, as there are usually different dosing levels, drugs and combinations of both, that can be studied resulting in a factorial solution. For example, to find the optimum combination from four dose levels of four different drugs there are 256 (4^4) possible combinations or groups to be studied. Additionally, differing modes of administration make the situation even more complicated. In effect, the dimensionality problem has generally limited studies to only considering two or three drugs in combination due to the number of patients

required. An example is the study by Minto et al. (2000) where combinations of midazolam, propofol, and alfentanil were studied and the authors needed 400 subjects to identify an optimum combination of three drugs for loss of consciousness. The process of the direct-search methodology is not unlike and can be described as similar to a multidimensional amoeba crawling along a response surface, sending out sensing pseudopods or combinations, with the elimination of poorly performing combinations advancing the complex to then converge on a peak or optimum combination on the surface (Berenbaum, 1990; Sveticic et al. 2003). Typically, six different combinations are studied as part of a complex. The outcomes are rated and the centroid of the complex is advanced away from poorly performing combinations to suggest more optimal combinations for further evaluation. This process continues until no further improvements occur, or indeed a peak is passed with evidence of worsening outcomes. Further mathematical refinements, which decide on the identification and partitioning of complexes based on performances and outcomes, potentially accelerate an already efficient search algorithm. Therefore, the number of subjects needed to have an effective trial is much lower than expected for such dimensionality problems.

Direct search designs have the distinct advantage where subjects are scarce and the treatments are not without risk, such as with cancer chemotherapy. This clearly does not apply to the setting of anaesthesia. The disadvantage, however, is that as the sample sizes are small, there is little certainty or precision with any estimates. Rather, certain combinations are suggested as attractive for future study. Therefore, although it has been of interest to see these methods have been applied to assess anaesthetic drug combinations, the impact of the results has not been as impressive.

Conclusion

Clinical pharmacology of dose-finding designs is progressing further with trials that combine methodologies such as isobolography and up-down designs, which can address issues such as addition, synergism and antagonism (Columb, 2006). Clearly, the trend to using dose-finding rather than fixed dose designs will improve further our understanding of clinical pharmacodynamics. ■

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bio- and medical informatics into biomedical informatics, or smart clinical tools. One example that my own group is developing is called SmartWarf™, used to incorporate genetic testing along with other clinical modifying factors to provide dose-finding guidance for the most widely used anticoagulant medication, warfarin. SmartWarf™ is currently for use in hand-held computing devices, but similar tools are being incorporated into health information systems, using other genes and other medications.

Example applications for intensive care

To the author's knowledge, there are no point of care pharmacogenetic tests currently on the market. This reduces the ability to use a new genetic test order to make immediate dosing decisions in the emergent setting. Probably of more use at this time in the critical care setting is the ability to provide dose guidance based on past test results. This is really only practical with a "smart" electronic health record. Such systems are emerging in the in-patient care setting in the United States, as well as in organizations such as the U.S. Veteran's Administration medical system. There is also a movement, with the advent of Medicare Part D, to build a U.S. national electronic medical record system. This would be an enormous advantage for pharmacogenetics.

Human genomic DNA, practically speaking, will not change over a person's lifetime. This provides opportunities to use previous test results in new settings, as well as to use archived DNA specimens to run new tests, thereby reducing turnaround time. The genes most useful in the critical care environment at this time are given in Table 1.

Health-Point Cards coming to a physician's office near you?

The invariable nature of genetic information lends itself to being tested once, and simply queried at the appropriate time, when needed. Now that whole genome sequencing is a reality and is economically feasible, there will be a need to store this information in a secure, universally acceptable way. Healthcare providers could use electronic data card technology to access genetic code information or, in fact, the patient's entire medical record, using the appropriate access code. The groups that would stand to benefit the most from such a system, in the form of cost savings from reduced duplicate diagnostic testing alone, should be of enormous interest to healthcare benefits managers, be they private or governmental organizations. The patients that will benefit the most from readily accessible to genetic and other medical information are undoubtedly those in critical care. ■

Recognition of the critically ill

The use of early warning scores

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"Patients do not die of their disease. They die of the physiological abnormalities of their disease."
Sir William Osler

Introduction

Recognition of the critically ill patient is of paramount importance and is often sub-optimal (Goldhill 2001; McQuillan et al. 1998). It is known that small changes in physiological parameters occur before marked clinical deterioration and inappropriate or delayed action in response to these changes can lead to increased mortality (Goldhill et al. 1999; McQuillan et al. 1998). The reality is that many patients are referred to critical care after they have suffered an *'unexpected'* cardiac arrest and that deterioration in physiological parameters pre-arrest, although often noted, go untreated (Buist et al. 2002; Goldhill et al. 1999; Schein et al. 1990). To prevent this, a proactive rather than reactive approach is needed. This requires a co-ordinated team approach with timely interventions targeted to the patients' needs before catastrophic deterioration occurs (Buist et al. 2002; Goldhill 2001).

Generic physiological based 'early warning score' (EWS) systems have been developed to aid the recognition of the critically ill patient (Goldhill and McNarry 2004; Goldhill et al. 1999; Subbe et al. 2001). EWS systems are now commonly used in many settings ranging from emergency departments, acute admission units and theatre recovery suites to general medical and surgical wards.

What is an early warning score?

An EWS is a simple, reproducible score, calculated at the bedside, to identify patients who are, or are at risk of becoming, critically ill. An EWS can be recorded by any staff member and provides a structured approach to the interpretation of simple bedside observations (Subbe et al. 2005). It incorporates a series of routinely recorded physiological measurements into a pre-defined scoring scheme (figure 1, p.22). Points are awarded for deviation away from the *'normal'* range.

As changes in physiological parameters occur before clinical deterioration, at-risk patients can be identified from the EWS, allowing more opportunity for timely interventions (Paterson et al. 2006; Rivers et al. 2001; Subbe et al. 2003). The EWS also provides a simple means of tracking trends in physiological parameters before and after any given intervention, e.g. fluid bolus, oxygen administration. As such, they are also described as *'track and trigger'* systems.

No scoring system is ideal for every clinical scenario. Since the original introduction of EWS systems, several modifications have been published although each contain the core bed-side observations of heart rate, blood pressure, respiratory rate, mental state and temperature. All follow the same principle of measuring physiological parameters and scoring them in relation to a reference *'normal'*. For each parameter, the greater the physiological abnormality the greater is the score. The scores for each individual parameter are summated to give the overall EWS. The higher the EWS the greater the need for critical care admission or risk of death (Goldhill and McNarry 2004; Goldhill et al. 2005; Subbe et al. 2001). Surprisingly, age is not a standard variable recorded in all EWS systems, although the effect of adding an age threshold is a proven independent variable in predicting outcome (Goldhill and McNarry 2004; Subbe et al. 2001). Other variables could be added, however, a balance is needed between usability and complexity (Paterson et al. 2006).

The EWS should be recorded, ideally on the patient's observation chart. There should be clear instructions regarding the EWS triggers for escalating observations and requesting medical assessment (Table 1).

An accepted international EWS would be useful (Paterson et al. 2006), especially for staff rotating between hospitals. In the absence of a standardised EWS used in all hospitals, the individual scores and EWS thresholds must be clearly defined and readily accessible. There is a concern that mistakes could occur where subtle differences exist between different hospital EWS systems. Recently a standardised cardiac arrest number was introduced into all UK hospitals following similar concerns.

When to calculate an EWS and what to do next?

An EWS can be recorded on any patient at any time if any staff member is concerned about the patient's condition. For any given unit (e.g. an acute admission unit), it is easy to instigate a policy to record an EWS on patient admission. The first EWS can be used to determine the frequency of subsequent observations. This is especially appro-

priate for acute medical patients who are most likely to be critically ill at the time of admission (Subbe et al. 2001). Continued observations are necessary to identify a patient whose clinical state subsequently deteriorates. Early identification through an EWS may allow intervention before the patient becomes critically ill. The usefulness therefore of an EWS is dependent on the frequency of observations performed and the ability of ward staff to recognise the cardinal signs of a patient becoming unwell.

Recognition of a deteriorating or critically ill patient is only the initial step. The use of scoring systems encourages the ethos that any team member can alert senior/critical care staff that a patient is unwell (Ridley 2005). The EWS must be used with an organisational pathway. There is little point in recording an EWS if there are no clear instructions on what to do with that score. In general, a score greater than the hospital *'trigger'* value should lead to a patient review by a member of the medical staff and increased observation frequency. The exact member of the medical team to be contacted and the time limit for this review should be determined by the individual hospital (Paterson et al. 2006). Staff education is very important. Staff must recognise the importance of the EWS, calculate it correctly and summon senior nursing and medical assistance appropriately.

Should this medical attention be from a junior doctor or a more experienced clinician?

In many circumstances, it is usually the most junior member of the team who is called to a deteriorating ward patient. As such, the system relies on the junior doctor's skills to recognise the severity of the situation and respond appropriately. In some institutions, EWS systems are used to triage patients. Those with a low EWS are seen by junior medical staff whilst those with higher scores are seen by more experienced staff. Where critically ill patients are seen by senior clinicians, it is important that junior staff are taught how to recognise and manage the critically ill.

Establishing an EWS system

Good education of all staff involved in patient care is paramount for the success of any EWS system as is the support of all senior staff. This requires an education programme, which includes every member of ward staff and every doctor, and stresses the importance of a team approach. It must give emphasis to the aims of the EWS system and the importance of quick and appropriate responses at all levels. In our institution, we provided designated members of the critical care nursing staff who visited all wards on a frequent basis and ensured all staff were appropriately trained in the use of the EWS system before its implementation. Nursing and medical staff from critical care also taught medical staff of all levels, both formally and informally, about the EWS system and response policy. An ongoing educational programme must exist to ensure all new staff are trained whilst re-emphasising the importance of the EWS system to existing staff members.

Score	3	2	1	0	1	2	3
Systolic BP (mmHg)	<70	71-80	81-100	101-199		>200	
Pulse rate		<40	41-50	51-100	101-110	111-129	>130
Respiratory Rate		<9		9-14	15-20	21-29	>30
Temperature		<35		35-38.4		>38.5	
AVPU Score				A	V	P	U

Table 1: Modified Early Warning Score (Subbe et al. 2001)
Calculation of an EWS: A patient is admitted to an acute admission unit. On arrival, the respiratory rate is 19/min, blood pressure 82/55mmHg, pulse 127bpm (irregularly irregular) and temperature is elevated at 38.6° Celsius. The patient is drowsy although responding to voice. The EWS is therefore seven. This patient was a 58 year-old male admitted with lobar pneumonia complicated by atrial fibrillation on the background of significant ischaemic heart disease and left ventricular dysfunction.

In many hospitals, the initial observations are performed by healthcare assistants (HCAs) and not qualified nursing staff. These HCAs must understand the importance of recording every physiological parameter of the EWS and calculating a total score. Early audits within our own hospital demonstrated that in many cases not all observations were performed, in particular the respiratory rate (known to be the most important of these parameters) was omitted and therefore an EWS could not be calculated. These HCAs must feel reassured that they can report any concerns to a senior member of staff. The senior nursing staff similarly must know the importance of the score and ensure that medical support is requested. The doctor must recognise the importance of the score, the need to assess and treat the patients promptly and the importance of seeking senior help. The escalation plan should also link into the outreach and critical care services in the hospital, so that the critically ill are referred appropriately. The system fails if any link in this chain fails.

Patient Sticker

South Tees Hospitals NHS
NHS Trust
Early Warning Observation Score Chart

Date						
Time						
Temperature C						
Blood Pressure mmHg (score systolic only)						
Heart Rate/Pulse (beats/minute)						
Resp Rate (breaths/minute)						
CNS score						
Urine score						
Total EWS						
Sp02%						
02%						
Pain score						

Score	3	2	1	0	1	2	3
Urine output (mls per hour if catheterised)	Nil	<20ml	<30ml		>100ml		
Conscious level (CNS)			Confused C	Alert A	Voice V	Pain P	Unconscious U

Figure 1: Generic Modified Early Warning Score Observation

Staff are often reluctant to request senior help and every opportunity for positive feedback should be taken. We have developed documentation on the reverse of the EWS chart to record every response. This stresses the importance of the action and enables audit. The EWS scores and responses should be audited regularly to re-emphasise the importance of responding appropriately. Any cases resulting in an adverse outcome should be reviewed and any learning points fed back.

The use of an EWS within intensive care units is of limited value. In this environment, patients are continuously monitored and each physiological parameter considered separately with acceptable ranges defined for each patient.

Limitations

The limitations of EWS systems relate to their generality. The EWS uses physiological parameters independent of pre-existing chronic illness. This ensures they have a high specificity for identifying the critically ill patient, although low sensitivity (Subbe et al. 2005). As with all screening tests, the scoring system needs to be taken in the context of the patient's pre-existing health problems.

For example, consider a patient admitted via the acute medical admission unit. The patient is mentally alert, pulse 104bpm, BP 80/44mmHg, oxygen saturation 94% on room air, respiratory rate 18/min and temperature normal. The patient's EWS is four (figure 2). If this were a 76-year-old patient with a history of ischaemic heart disease with significant left ventricular systolic dysfunction and chronic airways disease, these observations may be acceptable. However, if the patient was a 19-year-old university student and a friend had been admitted in the previous 24 hours with suspected meningococcal septicaemia, these observations would be a cause for concern. The clinical context must clearly be taken into account.

The introduction of EWS systems has been shown to improve the recording of physiological variables. It remains to be seen if EWS systems significantly and consistently improve patient outcomes (McBride et al. 2005; Paterson et al. 2006; Priestley et al. 2004; Subbe et al. 2003).

Other scoring systems

Over the last decade other scoring systems have been introduced for a number of medical and surgical conditions. These scoring systems, unlike an EWS, are disease specific and are used to calculate an outcome related to that specific disease process. For example, validated scoring systems specific to patients with acute coronary syndromes (ACS) have been developed (e.g. TIMI risk score). These highlight the critically ill ACS patient and provide an estimation of the risk of death/re-infarction in the short and long term (Antman et al. 2000). Validated scoring systems have also been developed to predict the risk of death and re-bleeding in patients with acute upper gastrointestinal (GI) bleeding (e.g. Rockall score (Rockall et al. 1996)). Disease-specific scoring systems predict

disease-specific outcomes and are usually only calculated once. Although some degree of overlap is unavoidable, they can and should be used together with an EWS. For example, sequential use of an EWS might alert a medical team to the possibility of a GI bleed, but once the diagnosis is established, the disease-specific scoring system may be more useful in aiding initial management. With most physiologically based EWS, the primary outcome is prediction of critical illness and the subsequent need for escalation of care. They are designed to alert staff of illness severity and need to be calculated repeatedly to identify deterioration (Ridley 2005). Combining the EWS with a disease-specific score may enhance delivery of optimal care to the patient.

Conclusion

Changes in physiological parameters occur before clinically catastrophic deterioration. EWS systems are valuable tools for the early recognition of high-risk hospital in-patients. Their widespread use is to be encouraged so long as appropriate action is taken once an at-risk patient is identified. A clear escalation policy and staff education are required to ensure that these patients, when identified, receive appropriate management. ■

Early Warning Observation Score (EWOS) Protocol/Action Flow Chart

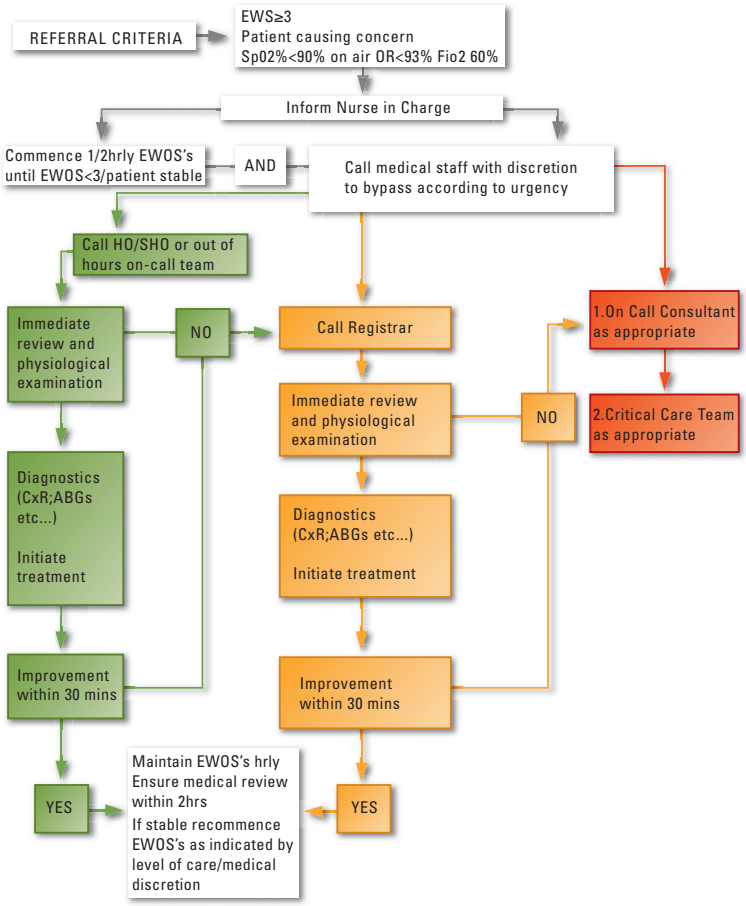

Figure 2: EWOS Protocol/Action Flow Chart

continued from p. 17

To reduce the probability of selection errors, several actions could be combined such as limiting the variety and quantity of available drugs, improving the stowage of drugs or syringes in medication cabinets, trolleys or trays, increasing the visual differentiation of drugs, syringes or injection lines using shapes or labels. In particular, labels should always mention complete drug strength information, concentration, amount and volume, and be printed at fixed locations. Labels should also incorporate Tall-Man letters, as well as colour to discriminate between different drug classes, and be attached to ampoules along their main axis. Decreasing the probability of check failure could be obtained via a variety of complementary means such as checklists, barcodes, electronic tags and dedicated line connectors in addition to continuous education and team work.

Prevention of other errors

Although our model still does not detail the various mechanisms leading to other errors, several options for prevention can already be mentioned. Developing dilution protocols and standardising dilutions across healthcare institutions could be a first step to limiting dilution errors. But resorting to ready-to-use products prepared either by hospital pharmacies or pharmaceutical companies could represent a decisive fix. Labelling errors could be reduced by filling up and identifying syringes one at a time and more effectively, by using, once again, ready-to-use products. Finally, information technologies could have the potential to limit amount/flow, time and patient errors. For instance, having medical devices coupled with computerised physician order entry systems could help to administer accurate boluses and select appropriate flows, whereas electronic reminders could facilitate the timely administration of drugs. In addition, reading barcodes or electronic tags both on patient wrist bands and drugs could contribute to a reliable verification of drugs administered to the patient. ■

PCA Infusion Pumps

ECRI Europe

ECRI is a totally independent nonprofit research agency designated as a Collaborating Center of the World Health Organization (WHO). Such organizations are appointed to contribute to WHO's public health mission by providing specialized knowledge, expertise, and support in the health field to the WHO and its member nations. ECRI is widely recognized as one of the world's leading independent organizations committed to advancing the quality of healthcare with over 240 employees globally.

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

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

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Footnotes used in pages 25 to 28

1. These recommendations are the opinions of ECRI's technology experts. ECRI assumes no liability for decisions made based on this data.
2. B Braun is the exclusive distributor of Curlin pumps, IV administration sets, and accessories in the USA.
3. start/stop pump, start/stop infusion, pump serial number, manufacturing date, user access code, next maintenance date
4. start/stop pump, start/stop infusion, pump serial number, manufacturing date, user access code, next maintenance date

Healthcare Product Comparison System

	ECRI RECOMMENDED SPECIFICATIONS[1]	FRESENIUS KABI
MODEL	**PCA INFUSION PUMPS**	**Master PCA Pack**
WHERE MARKETED		Worldwide, except North America
FDA CLEARANCE		No
CE MARK (MDD)		Yes
CONFIGURATION	Any	Locks to IV pole, tabletop
PCA DOSE BUTTON LOCATION	Bolus cord or pump	Handset
RESERVOIR		
Type (volume, mL)	Any (≥30)	Syringe (20, 50/60)
Configuration	Any	Syringe
Access	Key, lockbox	Key
DISPLAY TYPE	LCD or LED	Graphic LCD
Data displayed	Dose, concentration, lockout interval, rate, patient requests, alarms	Comprehensive messages and trends
CONTROLS		
Type	Keypad preferred	Rotary knob, keypad
Access	Key or security code	Electronic key, security code
PUMPING MECHANISM	Any	Stepper motor, lead screw
ACCURACY, %	5	2, drive accuracy
CONTINUOUS FLOW		0.1 - 1200 ml
Increments, mg/hr or mL/hr	0.1 mL/hr or equivalent mg or µg	0.001 to 0.1 mg/hr
LOADING DOSE	Yes	0.001 - 99.9 mg
BOLUS DOSE	Yes	0.001 - 99.9 mg
Increments	0.1 - 25 mL	0.5 µg, 1µg, 0.1 mg
DOSE PROGRAMMED	Yes	Yes
Concentrations	0.1 - 100 mg/mL	0.0001 - 99.9 mg/mL
LOCKOUT INTERVAL RANGE, min	≤5 - 100	1 - 720
MRI COMPATIBLE	Desirable	Not specified
ALARMS/INDICATORS	www.icu-management.org	www.icu-management.org
FREE-FLOW PROTECTION	Yes	Not specified
ACCUMULATED DOSE LIMIT	Yes	0.01 - 9,999 mg over 1 - 12 hr
SAFETY FEATURES	Lockbox, locking keypad, memory protection, tamper evident	12 hr limit, program-access electronic key, lockable cover, limit dose, occlusion and line-disconnection alarms
EVENT LOG	Yes	Yes
Display	Yes	Yes
Printout	Yes	Yes
Number of events	≥200	1,500
Time retained	1 year	Indefinitely
Data stored	Event history, drug infused, settings, alarms	Parameters and changes, time demand, doses, demand attempts
BATTERY TYPE	www.icu-management.org	www.icu-management.org
PURCHASE INFORMATION	www.icu-management.org	www.icu-management.org
WARRANTY	Yes	1 year
OTHER SPECIFICATIONS	www.icu-management.org	www.icu-management.org
LAST UPDATED		June 2007

Healthcare Product Comparison System

	ECRI RECOMMENDED SPECIFICATIONS[1]	BAXTER	BAXTER	BAXTER
MODEL	**PCA INFUSION PUMPS**	**Ipump**	**PCA Infusor with Patient Control Module**	**Syndeo PCA Syringe Pump**
WHERE MARKETED		Worldwide	Worldwide	North America
FDA CLEARANCE		Yes	Yes	Yes
CE MARK (MDD)		Yes	Yes	No
CONFIGURATION	Any	Ambulatory (carrying bag), locks to IV pole	Patient worn	IV-pole mounted
PCA DOSE BUTTON LOCATION	Bolus cord or pump	PCA cord, pump keypad (if configured)	Patient control module	Bolus cord
RESERVOIR				
Type (volume, mL)	Any (≥30)	Locking bag cover (100/250/250E/500)	Baxter (60)	Baxter prefilled (50), Monoject (60), BD (60)
Configuration	Any	IV Fluid bag	Inflatable balloon	Syringe
Access	Key, lockbox	Key, lockbox	Backcheck valve	Key
DISPLAY TYPE	LCD or LED	Backlit LCD	None	Color touchscreen
Data displayed	Dose, concentration, lockout interval, rate, patient requests, alarms	Programming steps, alarm status, Rx and patient history, power/therapy status, others	N/A	Battery level, date, time, icon driven, alarms/alerts with diagnostic instruction, value/range limits and prescription order
CONTROLS				
Type	Keypad preferred	Keypad prompts, security code, integral locking bag reservoir, and locking pole clamp; pump detects when lockbox is unlocked and records the event in history	Push button	Push button
Access	Key or security code	Key or security code	N/A	Key, security code
PUMPING MECHANISM	Any	Linear peristaltic	Elastomeric balloon	Covered lead screw/stepper motor
ACCURACY, %	5	8	10	5 (nominal)
CONTINUOUS FLOW		0.2 - 90 mL/hr	No	0.1 - 99.9 mL/hr
Increments, mg/hr or mL/hr	0.1 mL/hr or equivalent mg or µg	0.1 mL/hr, 0.01 µg/hr, 1 µg/hr	N/A	0 - 99.9 mL/hr in 0.1 mL/hr increments
LOADING DOSE	Yes	0.2 - 9.9 mL	No	Yes
BOLUS DOSE	Yes	0.2 - C379.9 mL	Yes	0.1 - 9.9 mL
Increments	0.1 - 25 mL	0.1 mL	0.5 mL/dose (fixed)	0.1 mL
DOSE PROGRAMMED	Yes	Yes	No	Yes
Concentrations	0.1 - 100 mg/mL	mg/mL, µg/mL	N/A	mg/mL, µg/mL
LOCKOUT INTERVAL RANGE, min	≤5 - 100	1 - 60/1 hr, 1 - 240/4 hr	6, 15, 60	3 - 240
MRI COMPATIBLE	Desirable	No	Not specified	No
ALARMS/INDICATORS	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
FREE-FLOW PROTECTION	Yes	Set-based, antisiphon valve	Not specified	Yes
ACCUMULATED DOSE LIMIT	Yes	90 mL/hr total	0.5, 2, or 5 mL/hr	1 and 4 hr
SAFETY FEATURES	Lockbox, locking keypad, memory protection, tamper evident	Configurable limits (units, infusion modes, max PCA dose, max basal rate, max bolus dose), 3 configurable safety modes, visual and audible alarms	None specified	Locking syringe cover with key, locking IV-pole clamp, security code with key, antisiphon valve, plunger retainers/pusher block, syringe-misload detection
EVENT LOG	Yes	Yes	No	Yes
Display	Yes	Yes	N/A	Yes
Printout	Yes	Yes	N/A	Yes
Number of events	≥200	400	N/A	1,000
Time retained	1 year	Rolling 400 events with 3-year internal-battery backup	N/A	Until cleared
Data stored	Event history, drug infused, settings, alarms	Cover unlocked, start/stop, bolus start/infused, dose limit reached, end, alarms, Rx changes	N/A	Prescription order, PCA events, alarms, user actions
BATTERY TYPE	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
PURCHASE INFORMATION	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
WARRANTY	Yes	1 year, extended available	N/A (disposable)	1 year, limited
OTHER SPECIFICATIONS	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
LAST UPDATED		June 2007	June 2007	June 2007

ECRI RECOMMENDED SPECIFICATIONS[1]	CARDINAL HEALTH	CARDINAL HEALTH	CURLIN MEDICAL [2]	CURLIN MEDICAL [2]
PCA INFUSION PUMPS	**Alaris PCA Module**	**IVAC PCAM PCA Syringe Pump**	**4000 CMS**	**PainSmart**
	Canada, USA	Worldwide, except USA	Primarily North America	Primarily North America
	Yes	No	Yes	Yes
	Yes	Yes	Yes	Yes
Any	IV-pole mounted, modular device used with Alaris system	IV-pole mounted	Lockbox; patient worn or IV-pole mounted	Lockbox; patient worn or IV-pole mounted
Bolus cord or pump	Bolus cord	Handset	Bolus cord and button on pump	Bolus cord and button on pump
Any (≥30)	Syringe (20 - 60)	Syringe (20 - 100)	Lockbox (100, 250, 500)/syringe	Lockbox (100, 250, 500)/syringe
Any	Syringe	Syringe	IV bag, syringe	IV bag, syringe
Key, lockbox	Lockbox key or security-code keys	Lockbox	Lockbox with key	Lockbox with key
LCD or LED	LED (backlist LCD on Alaris PC point-of-care unit)	Backlit LCD	Graphic LCD	Large graphic LCD
Dose, concentration, lockout interval, rate, patient requests, alarms	Current infusion program, VTBI, patient history, detailed patient history, rate, channel message, drug-event history on Alaris PC point-of-care unit	Protocols, history, start/stop, time, amount/drug infused, pattern of use, events	Line pressure, user prompts, help screens, battery life, delivery mode, amount delivered, rates, bolus given/attempts, amount and time remaining	Line pressure, user prompts, help screens, battery life, delivery mode, amount delivered, rates, bolus given/attempts, amount and time reamining, medLIMITS
Keypad preferred	Touch-control keys	Touch-control keys	Touch-control keys, point-and-click with PDA	Touch-control keys, point-and-click with PDA and bar code
Key or security code	Self-prompting	Self-prompting	Self-prompting with pump	Self-prompting with pump
Any	DC motor, lead screw	DC motor, lead screw	Proprietary curvilinear peristaltic	Proprietary curvilinear peristaltic
5	2	2	5	5
0.1 mL/hr or equivalent mg or µg	0.1 - 999 mL/hr (varies with syringe size) mg/hr, µg/hr, mL/hr	0 - 90 µg/hr, 0 - 999 mg/hr, 0 - 35 mg/hr (varies with syringe size) mg/hr, µg/hr, mL/hr	0.1 - 50 mL/hr PCA, 0.1 - 25 mL/hr epidural 0.002 mL/hr or equivalent mg or µg	0.1 - 50 mL/hr PCA, 0.1 - 25 mL/hr epidural 0.002 mL/hr or equivalent mg or µg
Yes	0.1 - 99 mg, µg, or mL	0 - 999 µg, 0 - 99 mg, 0 - 99.9 mL	Yes	Yes
Yes 0.1 - 25 mL	Yes Configured according to hospital best-practice guidelines	Yes 0.1 - 99.9 mg in 0.1 - 1 mg steps	Yes 0.1 - 50 mL IV, 0.1 - 25 mL epidural	Yes 0.1 - 50 mL IV, 0.1 - 25 mL epidural
Yes 0.1 - 100 mg/mL	Yes mg, µg, mL	Yes mg/mL, µg/mL	Yes 0.1 - 999 mg/mL, 0.1 - 999 µg/mL	Yes 0.1 - 999 mg/mL, 0.1 - 999 µg/mL
≤5 - 100	1 - 99 in 1 min increments	0 - 180	1 - 60	1 - 60
Desirable	No	No	No	No
www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
Yes	Set-based, integral antisiphon valve	Not specified	Active, integral set-based	Active, integral set-based
Yes	999 mL/hr	1 - 999 mg over 8 hr in 999 mL/hr 1 mg increments	0.1 mL	0.1 mL
Lockbox, locking keypad, memory protection, tamper evident	Lockbox with key or code access, optional pole clamp cover and server location enforcement	Lockbox	QC electronic programming through PDA and/or PC, integral set-based flow stop, pump-based free-flow protection, volume delivery limits in PCA modes, max of 0.1 mL cumulated and released at downstream occlusion	MedLIMITS to set upper and lower limits and increments on rates and boluses, maintains bolus schedule on repeat infusion, QC electronic programming through PDA and/or PC, integral set-based flow stop, pump-based free-flow protection, volume delivery limits in PCA modes, max of 0.1 mL cumulated and released at downstream occlusion
Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Pump, PDA, PC	Pump, PDA, PC
Yes	Via maintenance software	Yes	Yes	Yes
≥200	10,000 keystrokes, 2,000 events (will vary slightly based on text saved with each entry)	2,000	6,000	6,000
1 year	3 to 6 months of data, lithium battery for memory lasts ~5 years	First in, first out	Until cleared or overwritten	Until cleared or overwritten
Event history, drug infused, settings, alarms	Time, event, total drug infused, settings, key presses, alarms	Time, event, total drug infused, settings	Line pressure, volume over time, power type and usage, state of administration set, bolus attempted, bolus given, start/stop bolus, alarms, system errors, [3]	Line pressure, volume over time, power type and usage, state of administration set, bolus attempted, bolus given, start/stop bolus, alarms, system errors, [4]
www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
Yes	1 year	2 years	1 year	1 year
www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
	June 2007	June 2007	September 2006	September 2006

	ECRI RECOMMENDED SPECIFICATIONS[1]	Hospira	Hospira	SMITHS MEDICAL
MODEL	**PCA INFUSION PUMPS**	**GemStar**	**LIFECARE PCA with Hospira MedNet Software**	**CADD-Legacy PCA 6300**
WHERE MARKETED		Worldwide	North America	Worldwide
FDA CLEARANCE		Yes	Yes	Yes
CE MARK (MDD)		Yes	Yes	Yes
CONFIGURATION	Any	Lockbox; patient worn, IV-pole mounted, or tabletop	Locks to IV pole, tabletop	Pole-mount bracket (can lock to IV pole), ambulatory
PCA DOSE BUTTON LOCATION	Bolus cord or pump	Bolus cord or pump	Bolus cord	Pump; optional remote dose cord
RESERVOIR				
Type (volume, mL)	Any (≥30)	Universal lockbox, Hospira pre-filled vial or 250 mL bag	Abbott/Hospira 30 mL prefilled vials or sterile empty vials that have pharmacy-generated bar codes	Medication cassette (50, 100), IV bag (≤9,999), prefilled syringe (30)
Configuration	Any	IV bag, syringe, bottle, vials	Glass syringe	Medication cassette, IV bag or syringe
Access	Key, lockbox	Lockbox with key	Key	Key
DISPLAY TYPE	LCD or LED	LCD	Backlit LCD	LCD
Data displayed	Dose, concentration, lockout interval, rate, patient requests, alarms	Infusion amount, bolus demand and deliveries, alarms, event history, program and shift totals, time/date, therapy mode (PCA, epidural)	Settings, clinical care areas, drug type and concentration, drug delivered, alarm and operating conditions	Units, concentration, rate, dose, dose limits, doses given, dose attempted, total given, reservoir volume
CONTROLS				
Type	Keypad preferred	Touch-control keys	Touch-control keys	Softkey
Access	Key or security code	Self-prompting	Softkey	Operational code
PUMPING MECHANISM	Any	Piston driver, volumetric	Lead screw	Linear peristaltic
ACCURACY, %	5	5	5	6
CONTINUOUS FLOW		0.1 - 25 mL/hr	Variable from 0.1 - 20x concentration (mg/hr or µg/hr)	0 - 50 mL/hr
Increments, mg/hr or mL/hr	0.1 mL/hr or equivalent mg or µg	0.1 mL/hr or equivalent mg or µg	0.1 mg/mL or 1 µg/hr	0.05 mL/hr
LOADING DOSE	Yes	Yes	Yes	Without stopping
BOLUS DOSE	Yes	Yes	Yes	0 - 9.9 mL
Increments	0.1 - 25 mL	0.1 - 25 mL or equivalent mg or µg	0.1 - 5x concentration or 0.1 mL	0.05 mL/hr
DOSE PROGRAMMED	Yes	Yes	Yes	Yes
Concentrations	0.1 - 100 mg/mL	0.1 - 100 mg/mL or 0.1 - 1,000 µg/mL	0.1 - 50 mg/mL or 1 - 500 µg/mL	0 - 100 mg/mL, 0 - 500 µg/mL
LOCKOUT INTERVAL RANGE, min	≤5 - 100	1 - 999	5 - 120	5 - 1,440
MRI COMPATIBLE	Desirable	No	No	No
ALARMS/INDICATORS	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
FREE-FLOW PROTECTION	Yes	Set-based integral flow stop and integral pressure-activated antisiphon valve	Integral antisiphon valve	Yes
ACCUMULATED DOSE LIMIT	Yes	1 or 4 hr, number of boluses/hr or no limit	0.1 - 80x concentration	0 - 12 doses/hr
SAFETY FEATURES	Lockbox, locking keypad, memory protection, tamper evident	Lockbox, self-test, 1 or 4 hr limit, audible alarms, program/memory protection, shock resistant, bumper guards, configuration mode	Lockbox; self-test; 1, 4, 6, or 12 hr limit; audible alarms; program/memory protection; bar-code reader (drug name and concentration)	3 programmable lock levels, CADD extension sets with anti-siphon valves, cassette detection, upstream, occlusion, medication cassettes, security shell
EVENT LOG	Yes	Yes	Yes	Yes
Display	Yes	2-line, 16-character	128 x 64 pixels	Yes
Printout	Yes	Yes	Yes	Via PC program
Number of events	≥200	400	20,000, 400 viewable on pump	1,000
Time retained	1 year	1 year	1 year	≥5 years
Data stored	Event history, drug infused, settings, alarms	Event history, speed protocols, diagnostic history, 48 hr E20 bolus history	Requests, number delivered, opening/closing of security door, start/stop	Most recent 1,000 events
BATTERY TYPE	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
PURCHASE INFORMATION	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
WARRANTY	Yes	1 year	1 year; 90 days, battery	1 year
OTHER SPECIFICATIONS	www.icu-management.org	www.icu-management.org	www.icu-management.org	www.icu-management.org
LAST UPDATED		June 2007	June 2007	September 2006

Change management:

Part 1 – Sources of and barriers to change

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Introduction

This is the first of three articles in a series devoted to change management in the Intensive Care Unit (ICU). In this article, we will review a number of areas in ICU management and practice where adaptation and initiating change are likely to have high relevance and importance. We will also examine some of the barriers to successfully implementing change. In the second installment, we will look at the subject of leadership, focusing on the importance of leadership in initiating and maintaining change at all levels of the organization, and provide an overview of leadership theory. That discussion will also cover leadership characteristics mostly associated with success in creating and maintaining change. Leadership factors associated with organizational culture will be explored, as well. In the final installment, we will offer approaches to consider when undertaking the introduction of change in the ICU and provide some practical examples of change management.

Sources of Change in the ICU

The rate of change within healthcare is increasing as the conflicting pressures of consumers, producers and educational interests collide in an arena of limited resources (Bigelow and Arndt, 2000). Change may be viewed by some as an exciting opportunity to advance creative solutions, while others may view change as a negative force with loss of familiar surroundings and procedures, fear of the future and extreme frustration (Wagstaff, 2006). There are many factors that may act as driving forces in necessitating or promoting change globally within the scope of the entire healthcare system and within the specific domain of the intensive care unit. Some of these factors will be internal to the ICU staff, such as solving an identified process problem within the ICU. Some of the factors will be external to the ICU and may come from a variety of sources, including the hospital administration, governmental bodies, payors or regulatory agencies. Change is usually undertaken with a specific, targeted result in mind. These goals vary widely. Examples of strategic goals in the ICU include: improving quality of care, enhancing patient safety, containing costs, promoting patient satisfaction, improving efficiency of care, conforming to governmental requirements and meeting payor requirements for reimbursement.

Change can be classified according to the organizational level where the change initiative is occurring, the type of change being pursued or by the mode of change (Bigelow and Arndt, 2005). The type of change occurs across a continuum ranging from continuous change patterned on those procedures and processes that are already in place to radical and discontinuous change conceptualized by re-engineering. Mode of change refers to mechanisms ranging from determinism based on coercive pressure and imitative patterns to voluntarism driven by the vision and charismatic direction of transformational leadership. Examples of specific kinds of initiatives frequently associated with change in ICU operations include: alterations in the organizational structure of a department, division or entire institution; implementation of practice guidelines; promulgation of evidence-based therapies; and introduction of new technologies, such as information systems (e.g. computerized physician order entry or telemedicine). Additional initiatives may address new requirements for compliance in documentation required by payors including pay-for-performance initiatives, documentation of performance improvement and alterations in staffing patterns imposed by work hour restrictions for trainees. As can be seen from the above list, there is no shortage of factors that may force initiatives directed at changing the status quo in a particular ICU. The difficulty lies in the successful implementation of new ways of conducting business and in sustaining those strategies and processes that are effective after the initial introduction. This difficulty is best underscored by the high failure rate in business, where success is achieved in as little as 50% of all transformational attempts (Strebel 1996).

Barriers to Change

Barriers to change may result from systems issues within the institution, environmental factors or resistance from individuals at all levels of the organization, including senior leadership, management and staff. Leadership has been identified as a central element in successful change management and will be examined in detail in the next article in this series. Lack of effective leadership, including the ability of leadership to provide a clear vision of what change will accomplish and the effective communication of that vision throughout all layers of the organization, will create a significant barrier to change (Kotter, 1995). Leadership also has the responsibility to provide continued support, in order to maintain the change effort. Roadblocks to change

can be an unwelcome result when there is insufficient feedback provided to staff. Feedback should reflect a sense of real progress and success with regard to a specific initiative. This factor is more likely to become important with long-term projects and in situations where performance improvement data are not supplied to staff. Without feedback and encouragement, staff may believe their efforts are not having the desired effects, and they may, therefore, lose motivation. Leadership must also help build a strong consensus of key individuals within the organization to support the change effort.

Failure to identify obstacles, whether they are systems issues or relate to specific personnel, can rapidly undermine initiatives. In these cases, strategies to overcome and eliminate obstacles may be as important as the overall scheme for change. Other traps can be created when there is a failure to appreciate the time required to engage in tasks related to the change initiative and change implementation competes with the ability of staff to perform their required duties. In this instance, the new process is seen by the staff as disruptive and intrusive and is, therefore, unlikely to be followed. Such considerations are often important in implementing new technology, as the learning curve for staff can be steep. For example, ICU staff, finding that tasks take longer initially with a new information system, will naturally wonder why they should change from comfortable systems that seemed to work well in the past. An effective manager will anticipate this attitude and communicate to the staff the necessity and utility of the new process.

Closely linked to leadership is the notion of organizational culture. Organizational culture can be defined as patterned ways of thinking that are characteristic of an organization. This culture is comprised of values, beliefs, assumptions and biases. Within the context of the whole organization, many subcultures may exist (Wilkes et al. 2005). In implementing new processes, culture change is often required to prevent regression to the status quo. Failure to embrace new cultural norms can be an insidious barrier to successful change management; early phases of an initiative may appear to be on track, but as the process matures, momentum may be lost and old culture returns, thereby derailing the new process.

Perhaps the most studied change initiatives in medicine involve the implementation of practice guidelines. Barriers described in implementing guidelines include knowledge deficits, such as lack of awareness that a particular guideline exists, genuine lack of agreement with regard to the evidence, lack of motivation, low expectations that the interventions will translate to a favorable outcome, a tendency of change efforts to focus on the behavior of a single class of providers (i.e. physicians) rather than the entire ICU team and the tendency to direct efforts at people as opposed to the system (Cabana et al. 1999). Failure to consider the specific elements of a new system may result in a system that is unnecessarily complex. Complexity creates barriers by decreasing the likelihood of compliance and increasing the risk of error (Berenholtz and Pronovost, 2003).

In addition to those factors outlined above, other structural, personal and environmental barriers to change have been identified (Bosse et al. 2006). Structural barriers include: failure to provide adequate resources, including facilities, financial support, personnel and time. Personal barriers are related to the issues of knowledge, perception, attitude and motivation previously mentioned. Environmental barriers may result from a resistant culture fueled by political, economical and social factors opposing change. Barriers can be created at the start of a change initiative by failure to prepare the staff for the road ahead. Groundwork needs to be laid that encourages the staff to listen to messages they may not want to hear, question the standard operating procedure, and explore new ways of working (Garvin and Roberto 2005).

We have reviewed a number of factors present in the operations of intensive care units that may result in the introduction of change at various levels of the organization. Barriers to implementing initiatives leading to change in organizations have also been discussed. In the next installment, we will examine the role of leadership in change management and organizational culture. ■

Combining medicine and justice: ICU nurses can help heal patients' lives

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Critical care providers are often confronted with patients who may have been victims of crime, neglect or abuse. Nurses can easily combine their regular patient care duties with some basic forensic practices to help identify and protect these patients.

Introduction

Nurses in all healthcare settings have an ethical (and indeed, often legal) responsibility to report suspected criminal acts, including neglect and abuse, to the appropriate law enforcement authorities. In support of this, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) standards establish that: nurses have specific roles and responsibilities in relation to detecting and managing forensic cases; hospitals must establish criteria for identifying and assessing victims of abuse, neglect or exploitation; and all such assessments must be conducted in accordance with legal requirements for collecting and transferring evidence (JCAHO, 2006). Due to the serious nature of illness and injuries associated with violent crime, domestic abuse, neglect, accidents or drug overdose (among other medicolegal cases), the intensive care unit (ICU) often becomes involved in the care and treatment of these victims. Because ICU nurses interact closely and frequently with these patients, they are particularly well poised to serve as liaisons between medical and legal professionals, identifying possible forensic cases and preserving the evidence for law enforcement use.

A unique opportunity

Legal responsibilities aside, there are several important reasons for ICU nurse intervention when abuse or neglect is suspected. First, hospitalization places the victim in a controlled environment, where, under the watchful eyes of ICU personnel, victims should be safe from abuse for the duration of their stay. Furthermore, victims may be more willing to talk about their experiences while they are safe in the ICU. Even if the patient is not willing or able to talk, evidence collected upon ICU admission can help build a legal case against the abuser. From a practical standpoint, even if abuse cannot be confirmed, documentation of a nurse's suspicions and evidence collection (photographs of unusual bruises, for example) can help protect the hospital from liability for the patient's condition, should questions regarding the care provided arise. The ICU thus has a unique opportunity to apply forensic nursing to everyone's benefit.

Integrating forensics in ICU nursing

A nurse whose primary duties involve the provision of critical care should not be expected to specialize in forensic pathology, which is a discrete medical speciality with its own training program. However, the ICU should make an effort to provide basic forensic training to its nurses and implement policies and procedures that embrace essential forensic practices as an integral part of the standards of care (Lynch, 2006). Training and policies should cover each of the following areas.

Identifying forensic patients

Forensic patients include anyone whose condition has medicolegal implications, such as illness or injury resulting in insurance claims, personal liability or criminal charges. ICU nurses may not be the first medical professionals to come into contact with forensic patients, but they are ideally placed to identify and assess these patients, as they are often the first healthcare worker to complete a comprehensive screening and assessment process. Upon patient admission to the ICU, the nurse should conduct or assist the responsible physician with a "head-to-toe" assessment of all body surfaces, taking note of any suspicious conditions, as well as the conspicuous absence of certain findings. Table 1 shows some of the key "red flags" that ICU nurses should be trained to recognize. Nurses who suspect that they may be dealing with a forensic patient, even if the suspicion is no more than a "gut reaction" or hunch, should investigate the situation until their curiosity is satisfied.

Collecting Evidence

Frequently, the nurse is the only person in the right place at the right time to collect certain kinds of evidence. Only initial and periodic inspection of the entire body ensures that most significant medicolegal evidence will be collected. Once a forensic patient has been identified, as part of the initial inspection, the nurse should carefully record the patient's appearance and condition as a baseline within the medical record, noting particularly any questionable injuries or other signs of neglect or abuse. The nurse should continue to document changes in the patient's condition over time, taking

care to denote forensic observations using terminology that forensic pathologists will recognize, as similar terms are often used differently in critical care and forensic settings. Even the smallest observation may later prove critical.

Nurses should be trained to identify key sources of evidence, such as the victim's body itself, DNA and other evidence from saliva swabs, shoes, clothing and personal items accompanying the forensic patient to the ICU. They should also be trained to collect and handle evidence properly. Physical evidence, such as clothing or personal belongings, should be stored separately in clean paper or cardboard containers, to allow moisture to evaporate and avoid commingling evidence. In addition, nurses may record any observations they make in words, diagrams and/or photographs to document the patient's progress over time. All observations should be recorded as soon as possible after contact with the patient, to ensure thoroughness and accuracy.

Transferring Evidence

Chain-of-custody is critical to maintain the integrity of evidence in medicolegal cases. When a nurse collects evidence, he or she must ensure that the container holding the evidence is thoroughly fastened in a manner that will show clearly any tampering by unauthorized persons. The container should be labelled with the patient's name, date, current time, hospital number, contents and the name of the nurse who collected and bagged the evidence. All forensic evidence should be transferred to law enforcement authorities as soon as possible after collection. At transfer, the date and signatures of the giver and receiver should be written on the container. A duplicate transfer form should be kept with the patient's record. To protect against tampering or misplacement of evidence, the patient's belongings should accompany the patient from admission to release or transfer to law enforcement authorities. The patient's belongings must never be released to next of kin until law enforcement authorities have firmly established that the items have no evidentiary value.

Conclusion

ICU nurses frequently encounter forensic patients. Ethical (and often legal) obligations demand that ICU nurses intervene in possible forensic cases and refer them to the appropriate law enforcement authorities. Training ICU nurses to incorporate forensic examinations into their routine admission procedures may help the ICU to identify forensic patients who may otherwise go undetected and preserve valuable forensic evidence. By learning and performing simple forensic procedures, the ICU nurse can have a lasting impact on the hospital's ability to fill its medicolegal responsibilities, law enforcement's ability to pursue justice and the patient's ability to live a full life free of victimization. ■

"Red Flags" for Forensic Patients

* Evidence of drug or alcohol abuse
* Suicide attempt
* Vague physical or psychological complaints
* Malnutrition/dehydration
* Inconsistency between injury and explanation
* Repeat emergency department use
* Signs of physical neglect
* Unusual injury patterns
* Evidence of sexual assault
* Financial exploitation
* Prolonged interval between injury and treatment
* Fecal impaction
* Noncompliance/therapeutic failure
* Family discord/emotional abuse

Table 1: "Red Flags" for Forensic Patients

Risk analysis:
Techniques for improving patient safety in critical care

Andrew Smith, FRCA MRCP
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Introduction
The 'patient safety' movement has come about through an appreciation that the techniques and approaches that have been used to improve safety in other industries can be applied to healthcare (van der Schaaf, 2002). The underlying assumption in this approach, as in 'safety science' in general, is that systematic scrutiny and analysis of problems using rigorous methods can bring benefits.

A framework for studying safety
To analyse accidents and incidents, a structured way of thinking about them is needed. Reason's model of accident causation is well known in the field*. It suggests that there are many potential accidents and many potential contributing factors, but that most potential accidents are prevented from becoming actual accidents by a series of controls or *barriers*. When the controls fail, the accident that has been 'waiting to happen' can occur. Many factors can contribute to the genesis or development of an accident:

- a *patient*,
- an *individual* staff member,
- some aspect of the *team*, including *communication* amongst its members
- *education* and *training*,
- *equipment* and *resources*,
- *working conditions* and
- *organisational* and *strategic* issues.

These factors may act as *influencing factors* or as *causal factors*. Removing an influencing factor might not have prevented the accident, but it should improve the safety of care in general. Clearly, if a factor actually caused the accident, removing it should greatly reduce the risk of repeating the accident.

Barriers may be *physical* (e.g. keypad-controlled doors), *natural* (e.g. allowing time to pass before moving to next stage of process), *human* (e.g. checking the temperature of a bath before immersing an elderly patient) or *administrative* (e.g. protocols and procedures). Physical barriers are the most reliable in terms of providing failsafe solutions to safety problems. Natural barriers, whilst less effective, generally provide a more robust solution than human action and administrative barriers. However, in healthcare, there is a predisposition to relying on human action and administrative type barriers as solutions to problems.

Analysing incidents
Many intensivists are familiar with critical incident studies – a neighbouring speciality of anaesthesia which pioneered the use of critical incident reporting in healthcare. Creating a culture where incidents are readily reported may not be straightforward. Often, when something has gone wrong, many presume that a mistake must have been made and they will be blamed or disciplined. However, the reporting of incidents allows their analysis and possible identification and elimination of contributing factors. This technique is called root cause analysis (RCA) and, over the years, it has led to significant gains in safety in many fields of human activity.

Prospective techniques for identifying risks
However, although RCA is an effective technique and can prevent repetition of a given event, it is obviously a reactive process, taking place after harm has been done. New working practices, new equipment, collective forgetting and the pure capriciousness of chance all mean that the potential for new problems is always present. Prospective methods of risk identification complement the retrospective approach by attempting to tackle unforeseen hazards. An overall risk assessment strategy asks four questions:

1) 'What can go wrong?'
2) 'How, and how often?'
3) 'How bad?'
4) 'Is there any need for action?'

This last question is important. Often, the risk can be reduced and some action must be taken. Sometimes, however, successful risk management depends on learning to live with risk** (Institute of Risk Management, 2003). This can be difficult but if a systematic appraisal has been conducted, then this decision can be seen as the right one as supported by evidence.

A commonly used framework for analysis is to assess the effect (or severity) of the risk, its *likelihood*, and what *controls* or *barriers* exist to reduce it.

The choice of method to use depends on a number of factors, including the level of perceived risk and possibility of its mitigation, capabilities of staff, availability of data and type of system. Further, different techniques may be applicable at different stages of the same project, with more structured tools becoming necessary as a project progresses. Techniques within both groups can be classified into those with a 'top down' approach which start with potential hazardous outcomes and work backwards to analyse possible contributory factors and those with a 'bottom up' approach which start with processes or potential causes and try to predict the potential hazards, which could arise from them. These techniques vary considerably in complexity, need for training in their use, degree of structure and quantification, and so on.

Examples

An example of the use of these principles, relevant to intensive care, was published in 2004. Apkon and colleagues from a paediatric ICU in the United States used the technique of failure mode effects analysis (FMEA) to design safer processes for intravenous drug infusions (Apkon et al. 2004). FMEA is a tool originally developed by reliability engineers for the systematic evaluation of a complex process, the identification of elements that risk causing harm and the prioritisation of remedial measures. It estimates failure rates from various sources, including published literature, direct measurement and perceptions based on experience. The information is then used to predict the behaviour of a system. Apkon and colleagues put together a multidisciplinary team of staff including a pharmacist, intensivists, nurses and an epidemiologist. The team then identified the ways in which each element of the drug delivery process might fail. They characterised the elements or steps in the process, and for each element scored (1) the severity of failure should it not be detected (2) the likelihood of occurrence and (3) the likelihood that the failure will escape detection before causing harm. Multiplying the scores for the three elements together yielded a risk priority number, which allowed actions to reduce risks to be prioritised. Having identified that the biggest risks lay in the calculation of the correct infusion rate, in the bedside preparation of the infusion and in programming the infusion pumps, the team made a number of changes to improve the process. The hospital's existing computerised drug order system was modified to create a database of standard solutions. Calculations and formulation were also transferred to the computerised system. Pre-manufactured solutions were used wherever possible or infusions were prepared to order in the pharmacy. This allowed longer 'hang times' for infusions and, as the risk of an adverse event is related to the frequency of opportunity, thus reduced the overall risks still further.

My second example is within the wider field of perioperative care. A structured 'what if' technique was used to identify the non-operative risks associated with elective surgery under general anaesthesia in adults. It was co-ordinated by the UK National Patient Safety Agency in 2004 (Adedokun et al. 2006). Again, a group of participants from different backgrounds in healthcare was brought together to think systematically about potential hazards in current processes. To guide the process, 'what if' questions were raised (e.g. 'What if the wrong premedication were given?', 'How could process X go wrong?', 'Is it possible to…?', 'Has anyone ever been able to…?'). Members of the group were then asked to grade each risk they had identified according to its likelihood and severity, and these were incorporated into a risk matrix, used to rank the risks in order of importance. The study yielded a number of areas for attention, including perioperative hypothermia, neuromuscular blockade, training in airway maintenance devices and removing distractions for the anaesthesiologist. The main drawback was the time required. In many safety-critical industries, staff members are required to take part in such exercises and time is made available.

Conclusion

This article outlined the variety of prospective risk-analysis techniques available. Taking part in the processes of analysis does not only help tackle the specific risks identified, but it also has a beneficial effect on clinical and support staff, as their views and perception of all kinds of safety issues are often changed for the better. The techniques are simple in principle and I encourage readers to try them for themselves. I would be happy to be contacted for further help and advice. ■

**see www.npsa.nhs.uk/health/resources/root_cause_analysis*
***see www.theirm.org/publications/Pustandard.html*

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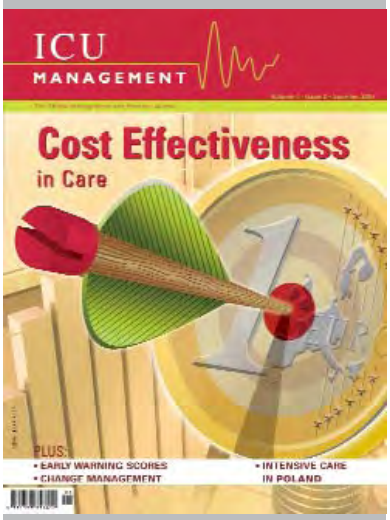

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An interview with **Claudio Ronco**

Prof. Claudio Ronco shares his management experience and vision as Director of the Nephrology Department at St. Bortolo Hospital, Vicenza, Italy.

May I ask you, by way of introduction to our readers, how long you've been the Director of your unit?

I have been director of the Department of Nephrology Dialysis and Renal Transplantation at St. Bortolo Hospital since 2002. Before that, I was director of the Renal Research Laboratory at the Beth Israel Medical Center of New York and a visiting professor at the Albert Einstein College of Medicine from 1999 until 2000.

What is your field of expertise/previous experience?

I am nephrologist by training. I received a specialization diploma in medical nephrology from the University of Padua in 1979 and in pediatric nephrology from the University of Naples in 1982. However, I have spent most of my life bridging the knowledge gap between engineering and medicine, and recently (in the last 15 years), between intensive care and nephrology. I have also delivered numerous lectures and seminars on these topics in several universities worldwide.

What are your primary duties as Director?

I manage the clinical care in all sections of the department, including the renal ward, the hemodialysis center, the peritoneal dialysis center, the critical care nephrology section and the transplantation center. Furthermore, I am responsible for coordinating our research program.

What sort of strategic planning is involved in managing your department?

This is an evolving field and managerial plans have to be continuously modified. For example, technology must be constantly upgraded and theoretical bases of new therapies need to be discussed in light of best-practice guidelines and new scientific evidence.

Give an example of two extremes in the types of tasks you have to fulfill.

On one side, I have to manage the large number of physicians and nurses of the department while on the other side, I have to discuss lab techniques of molecular biology and new designs for extracorporeal treatment machines.

What skills do you feel are the most essential to an ICU Manager?

The most important skill of all, I believe, is flexibility.

What is the hardest decision you've had to make as an ICU Manager?

It has been hard when, for lack of funds or sufficient personnel, I have had to drop a research plan or close an activity.

What has been the most satisfying experience as an ICU Manager?

Impacting the practice of Renal Replacement Therapy (RRT) in the ICU with our study on dose versus outcome in Continuous Renal Replacement

Therapy (CRRT). My team and I developed the so-called "Vicenza Model" of multidisciplinary approach to the critically ill patient with acute kidney injury.

Are there particular areas that you feel your department excels in and why?

In my opinion, we excel in technology testing, interdisciplinary education and renal replacement therapy.

In what areas would you most like to improve your department and why?

I would like us to improve our work on molecular biology and genetics because these areas represent the future of diagnosis and therapy.

What are the difficult issues that you feel ICU departments currently need to address in general?

A pressing issue, in my opinion, is the qualification of personnel in the new information technology tools that are available to us for the use in intensive care.

Professor Ronco with his team at San Bartolo Hospital, Vicenza, Italy

What are the major medical/clinical management issues that you currently face?

In management, I find it sometimes difficult to combine day-to-day practice with international guidelines.

What sort of economic, financial, budget, etc. are you currently dealing with?

I am struggling with the bureaucracy of the public healthcare system, although this covers the care of patients and at all social levels.

How do you measure the cost effectiveness of your unit?

In most non-Anglo-Saxon countries, cost effectiveness is predominantly measured by survival/hospital free days vs. utilization of resources and this is the method we also use.

What sorts of personnel issues are you currently dealing with?

We are faced with the problem of excessive workload, which prevents adequate strategic planning, study or development.

What do you believe are the major personnel challenges within the ICU community in general?

Nowadays, turnover and burnout are of primary concern.

Author guidelines

ICU MANAGEMENT

Content

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

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- main authors are requested to supply a portrait photo (see specifications below);
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Thank you,
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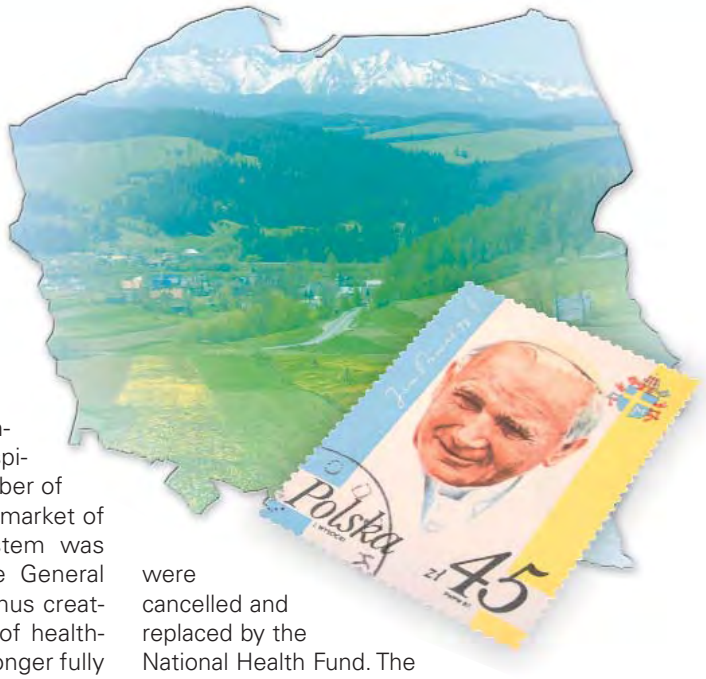
The healthcare system in Poland

Jacek Lukomski
Director of Regional Hospital, Poznan
Vice President of Union of Polish Health Care Employers, Poland



The reforms of the healthcare system in Poland were initiated in 1989 along with the reforms of the national economy. Their positive effects were manifested mainly by shorter hospitalisations, improvement of primary healthcare and effective management of hospitals even though a decrease in the number of hospital beds was noticed. A regulated market of services in the public healthcare system was established. On January 1st, 1999 the General Health Insurance Act was introduced, thus creating a new insurance-budgetary model of healthcare funding. The state budget was no longer fully responsible for funding health services. The separation of functions between the payers and the organisers/providers of healthcare services became a crucial matter. The number of private providers has been increasing since the reforms took place.

Health Insurance Organisations (HIOs) - autonomous, legally recognised, non-profit bodies, were established to guarantee that the insured individuals would receive the needed healthcare services. These were provided in cases of sickness, injury, pregnancy, childbirth as well as for health promotion and prevention of diseases. For the financing of these services, an HIO would collect premiums, which were paid by patients assigned to the given HIO. The HIOs were responsible for the management of the funds and of the contracted providers in order to render healthcare services, prophylaxis and health promotion. The Health Insurance Supervision Office, whose major responsibility was to protect the interests of insured persons, supervised the operation of the Health Insurance Organisations.

However, the solutions adopted by the General Health Insurance Act in 1999 for the reformation of the system proved insufficient. The number and quality of services in individual regions differentiated significantly: there were different service contracting policies in each regional HIO and sometimes the same service had different costs depending on the HIO. As a consequence, the Law on General Insurance in the National Health Fund (NHF) was enforced on April 1st 2003. Under this legislation, the Health Insurance Organisations were cancelled and replaced by the National Health Fund. The provision of health services to insured individuals was undertaken by the NHF branches, under the strict supervision of the Central Board of the Fund.

The next step of the NHF towards improvement of the healthcare system consisted of developing policies for healthcare service contracting and for the regulation of prices for each service. This led to the harmonisation of pricing of all healthcare services in the NHF regional branches and ended the unjustified differences. Nevertheless, the Law on General Insurance in the National Health Fund was met by criticism and in 2004 it was legally qualified as not standing in accordance with the Constitution. On July 30th 2004, the Parliament of the Republic of Poland passed the Law on Health Benefits Financed by Public Means. It defined the responsibilities of public and private firms cooperating with the State in the area of citizens' healthcare.

Financing the Polish Healthcare Systems

The national government budget has historically been the main source of healthcare financing. However, this changed in January 1999 with the introduction of the General Health Insurance Act. Funds then came from three main sources. First, the insurance fees covered the costs of healthcare services to the patients through their contracts with the relevant providers. Second, government budgets continued to finance public healthcare services, highly specialised services (such as organ transplantations) and very expensive drugs (such as immunosuppressive drugs). Third, self-governments (*voivodship, powiat* and *gmina*), as owners/organisers of the healthcare

services institutions, financed health promotion, prophylaxis of diseases and capital expenditures. However, in the reformed healthcare system, the involvement of the state and self-government budgets is limited. Since 1997, pre-hospital emergency services, public health targets, health insurance premiums for specific groups of the population (the unemployed, those receiving social pensions, farmers, war veterans and others), and investments in public healthcare institutions have been financed by those budgets. The resources from the state budget cover the costs of healthcare services provided in life-threatening situations, in case of accidents and childbirth to individuals who are not insured. The Ministry of Health may also cover the costs of treatment or diagnostic procedures abroad if these are not available in Poland. The list of highly specialised procedure financed by the Ministry of Health is very limited. Some procedures, formerly financed by the Ministry, have been taken over by the National Health Fund and its branches.

Healthcare insurance is obligatory for Polish citizens, who are categorised as those covered by social insurance (e.g. employees and farmers) and those who receive social security benefits. Other categories also exist, such as non-employed (unemployed and students), civil servants (e.g. military and police) and others (e.g. political refugees). All social groups are practically covered by obligatory healthcare insurance.

The Law on General Health Insurance determined a wide range of healthcare services, including those for the maintenance and restoration of human health, for the prevention of diseases and injuries, for early diagnosis, medical treatment, and for the prevention and alleviation of disabilities. Insured citizens are entitled to medical examinations and consultation, diagnostic examinations, preventive care, out-patient healthcare, medical emergency services, medical rehabilitation, nursing, supply of drugs, medical devices, orthopaedic devices and aids, peri-natal care during pregnancy, palliative care and certification of temporary or permanent disability. Insured individuals also have the right to choose their doctor, nurse, midwife of the primary healthcare, dentist and specialist benefits provider within the framework of out-patient healthcare, as well as their hospital from among institutions contracted with a *voivodship* branch of the NHF. The law determines the transparent rules of equal access to healthcare benefits. This is monitored by the voivodship branches of the Fund and by the Central Board Office.

The supervision of the National Health Fund is exercised by the Ministry of Health, while the financial economy of the Fund is supervised by the Ministry of Finance. The draft financial plan of the Fund is consulted with the Board of the Fund, the Commission of Health and the Commission of Finance of the *Sejm* (Parliament) of the Republic of Poland. The Minister of Health, in consultation with the Minister of Finance, has to approve the financial plan of the Fund. The insurance premiums payments are deducted from personal income tax (currently at the rate of 9%).

Factors influencing health in Poland

The percentage of overweight persons (with Body Mass Index (BMI) of 26 to 30), aged over 15 years, has risen to 20% in men and 14% in women. 13% of the male and 13% of the female population are massively overweight (with BMI over 30). Between 1996 and 2004, the share of smoking men has dropped from 47.3% to 38% and of smoking women from 24.5% to 23.1%. Approximately 17% of the population aged over 15 years suffer from arterial hypertension, 15.5% from vertebral column diseases, 8.6% from coronary arterial diseases and 7.4% from neurosis and depression. ■

Poland: general and healthcare fact sheet	
Population	38,174,000
Life expectancy	Men: 70.81 years, Women: 79.27 years
Total number of physicians	86,600
Total number of nurses and midwives	208,000
Total number of hospital beds	188,000 (Public sector: 183,800 beds in 739 hospitals; Private sector: 4,200 beds in 678 hospitals)
Total number of in-patient care admissions	6,651,000 patients per year
Total number of provided out-patient consultations	Public sector: 99,992,000; Private sector: 115,950,000

Intensive care in Poland

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The development of intensive care (IC) in Poland has been closely connected to the advances in anaesthesiology. The beginnings of these two fields in Poland go back to the 1950s and 1960s. The precursors of Polish anaesthesiology were Prof. Stanislaw Pokrzywnicki, who specialised in anaesthesiology under Sir Robert Macintosh at Oxford, and Assistant Prof. Mieczyslaw Justyna. The first Intensive Care Departments were established at the Medical Universities in Poznan (by Prof. Witold Jurczyk) and Wroclaw (by Prof. Antoni Aronski), in 1967 and the first Paediatric Intensive Care Department was set up in 1970 in the Paediatric Institute in Warsaw (by Prof. Tadeusz Szreter).

Standards in intensive care

An important step towards the development of IC in Poland was achieved in 1998. It was the elaboration, thanks to the efforts of the entire anaesthesiology community, of detailed guidelines and medical procedures regulating the provision of healthcare services in anaesthesiology and intensive care, issued as the Regulation of the Minister of Health of 27 February 1998. Among other issues, these standards defined area and equipment requirements applicable to IC departments, including detailed specification of equipment to be installed in bed units, as well as personnel standards (i.e. the required number of medical practitioners and nurses per a defined number of IC beds). Also according to the Regulation, IC departments may only be run by specialists in anaesthesiology and intensive care. In order to ensure that the relevant requirements are satisfied, the Regulation provided a period of five years for gradual purchase of the requisite equipment in all intensive care departments.

Training and education system

The Polish system of postgraduate specialisation courses for physicians incorporates one joint specialisation in anaesthesiology and intensive care. The specialisation training begins upon completion of one year's post-graduate internship and the state medical licensing exam. It takes six years to complete the specialisation training, which is conducted at selected and certified ICUs. Physicians, during specialisation, have two possibilities of employment: hospital jobs or medical residencies, both financed directly by the Ministry of Health. The programme of specialist training is designed to enable future specialists in anaesthesiology and IC to gain necessary knowledge of physiology, pathophysiology, pharmacology, preoperative treatment and postoperative care, clinical anaesthesia, intensive therapy, diagnostics and treatment of acute and chronic pain, emergency medicine and resuscitation. The programme involves both obligatory courses and specific internships. The title of specialist in anaesthesiology and IC is granted upon completion of the training and the state medical licensing exam. As part of continuing professional development, Foundation for European Education in Anaesthesiology (FEEA) courses have been held on a regular basis since 1995. The first course was in Poznan but currently, the courses are provided at four academic centres in Cracow, Poznan, Warsaw and Wroclaw.

Current situation

The latest statistics provided by the Ministry of Health (2005) show that out of a total number of 749 public-sector hospitals, 425 establishments had IC departments. The number of departments in different regions varied between 8 and 60. The total number of IC bed units in Poland was 2,417, accounting in different hospitals for between 1.5% and 2% of the total number of available hospital beds. In 2005, anaesthesiology and intensive care departments employed around 3,500 specialists in these disciplines corresponding to an average of 0.9 anaesthesiologists per 10,000 inhabitants.

Major challenges

Currently, the most important challenges that the sector is faced with and requiring urgent attention are to increase the number of IC bed units and to stop the 'brain drain' of specialists in anaesthesiology and intensive care to countries abroad. As the Ministry of Health estimates, during the past two years, around 20% of the anaesthesiology and intensive care specialists in Poland left the country being offered much higher pay for a lower workload. This also resulted in an increase in the average age of Polish specialists in anaesthesiology and intensive care, which is now 48 years for women and 52 years for men. The current situation may cause difficulties in maintaining minimum employment levels necessary to meet staffing requirements at IC departments. Another important challenge in the nearest future will be the introduction and, possibly, extension of the existing specialisation syllabus with elements elaborated within the Competency-Based Training in Intensive Care in Europe (CoBaTrICE), a programme launched by the European Society of Intensive Care Medicine (ESICM) with the objective of unifying the scope of knowledge, competence and skills required of intensive care specialists in the EU Member States. Poland's representatives in ESICM also made an active contribution to the development of CoBaTrICE.

Polish Society of Anaesthesiology and Intensive Therapy

The Polish Society of Anaesthesiology and Intensive Therapy was established in 1959 under the name Society of Polish Anaesthesiologists. It is a scientific society gathering and representing the community of anaesthesiology and intensive care specialists. The mission of the Society is to conduct and support research in topics related to anaesthesiology and intensive care, to cooperate in improving professional qualifications of Society members and work towards their high professional ethics, to spread the knowledge of anaesthesiology, intensive care, resuscitation and pain therapy, as well as to collaborate in the planning and organisation of the healthcare system in the represented medical specialisation. At present, the Society has thirteen regional divisions and six specialty sections (Historical; Cardiothoracic anaesthesia; Hyperbaric Medicine; Neuroanaesthetic and IT in Neurological Diseases; Paediatric, and Ambulatory Anaesthesia). The activities of the Society are coordinated by its highest authority body, the Board of Directors, which implements decisions and resolutions taken by the General Meeting of Members.

The Society pursues its goals by organising congresses, conferences and scientific meetings, as well as by educating in anaesthesiology, intensive care, resuscitation and pain therapy on both pre- and post-graduate levels. The Board of Directors is engaged in the development of postgraduate training programmes in anaesthesiology and intensive care. Since 1959, the Board has held national scientific congresses every three years. The latest, the 15th International Congress of the Polish Society of Anaesthesiology and Intensive Therapy, took place in Poznan in 2005. In 1990, the Polish Society of Anaesthesiology and Intensive Therapy also organised a Congress of the European Section of the World Federation of Societies of Anaesthesiologists (WFSA) in Warsaw. Since 1969, the Society has been publishing *Anaesthesiology and Intensive Therapy* – a specialist quarterly journal.

At the moment, the Society has 1660 members, both specialists in anaesthesiology and intensive care, as well as physicians in their specialist training in this field. In Poland, there are also the Polish Society of Emergency and Disaster Medicine (since 1988), the Polish Society of Emergency Medicine (since 2000) and the Polish Resuscitation Council (since 2001), all of which work in cooperation with the Polish Society of Anaesthesiology and Intensive Therapy. ■

Polish Working Group for Sepsis

Prof. Andrzej Kuebler
Head of Working Group for Sepsis,
Polish Society of Anaesthesiology and Intensive Care,
Poland

On November 19th, 2001 the Polish Society of Anaesthesiology and Intensive Therapy established a Working Group for Sepsis, motivated by the increasing worldwide interest in the syndrome and the lack of epidemiological information about its occurrence and course in Poland. In January and February 2002, the Group performed a survey assessment of the knowledge on definition, diagnosis and management of sepsis among medical personnel in Polish Intensive Care Units (ICUs). The results of the survey, published in the Polish Journal for Intensive and Emergency Medicine, demonstrated low awareness of problems associated with sepsis. The Group initiated broad educational activity in the form of courses and conferences and in April 2003, established its own website (www.sepsa.pl) with primary aim of propagating new information about sepsis and providing a platform for the exchange of opinions and knowledge on the syndrome.

Furthermore, the Working Group decided to start a web-based Severe Sepsis Registry programme, designed as a simple system of passive epidemiological surveillance. This type of surveillance is commonly used for the registration of nosocomial infections. The innovative aspect of the Polish Severe Sepsis Registry is that it gathers information not only about pathogens and infection, but also about the entire clinical picture of severe sepsis. The Registry is based on a questionnaire, completed after the end of severe sepsis treatment in an ICU. The participation in the surveillance programme is voluntary and the case presentation - anonymous. The participants have access only to their own data but are regularly provided with regional and national surveillance reports. Severe Sepsis Registry is constructed as an ongoing, longitudinal project and is now the main source of information on the subject in Poland since this syndrome is neither recognised by the International Classification of Diseases (ICD) nor obligatory entered into official hospital documentation. The Severe Sepsis Registry project has been widely accepted among Polish ICUs and up until April 2007, over 4,000 patient records have been entered by the 140 ICUs.

The provided data contains patient demographic information, organ dysfunction and infection characteristics, methods, results, and outcome of therapy. The results of the Registry show that severe sepsis in Polish ICUs is more frequently developed in men (58%), due to surgical disorders (54%) and with primary infection site the abdominal cavity (46%). Mean age of the patients is 54 years. Over 60% of severe case patients entered the ICU with three or more organ dysfunctions. Respiratory failure was the most common of them (95%), followed by circulatory failure (89%). Mean APACHE II score on admission was 24 and one-day mean TISS-24 value - 38. Pathogens, reported as the anticipated cause of severe sepsis, were G- bacteria (49%), G+ bacteria (39%) and fungi (12%). Positive blood cultures were obtained in 44% of the patients. Vasoconstrictors were used in 88%, mechanical ventilation in 88%, heparin in 82%, steroids in 56%, renal replacement therapy in 20%, and activated protein C in 9% of the cases. The mean duration of treatment in the ICU was 17 days and the average mortality rate - 54%. Interim analyses of surveillance data were performed and published after every 1,000th entered patient. Demographics, severity of disease, site of infections, all followed a stable pattern during the four years of observation but the distinctive trend of mortality reduction was observed: 2004 – 56%, 2005 – 51%, 2006 – 47%.

Even though, surveillance programmes for severe sepsis can adequately describe the characteristics of patients, infections, clinical course, management and outcomes, they are not able to assess the prevalence and incidence of severe sepsis. Therefore, the Working Group performed two one-day, point-prevalence studies on sepsis occurrence in Polish ICUs during two 6-month intervals between December 2004 and June 2005. 48% of all accredited ICUs in Poland responded. The mean values from the two studies showed that 34% of patients treated in ICUs had all forms of sepsis, 16% had severe sepsis and 6 % - septic shock. The calculated incidence of severe sepsis per year was 0.34 cases in a population of 1,000. This number does not include the septic patients treated outside the accredited ICUs, in intermediate care facilities and in general wards thus, the real incidence of severe sepsis is at least two to four times higher.

Considering its common incidence, high mortality, prolonged length of ICU stay and substantial costs, severe sepsis should be regarded as a major public health problem in Poland. The main goal of the Working Group for Sepsis is to achieve a 25% decrease of severe sepsis mortality in the next 5 years. For such outcome, it is necessary to achieve not only quality improvement in management process of severe sepsis but also strategic decisions in the national health service enabling the increase of ICU beds number for early implementation of critical care interventions in all severe sepsis cases. ■

European Society of Anaesthesiology

ESA

Copenhagen Euroanaesthesia 2008 Denmark

Annual Meeting of the European Society of Anaesthesiology

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European Society of Intensive Care Medicine: 25 Years of Progress and Innovation

Andrew Rhodes
Chairman of the ESICM Congress Committee

Rui Moreno
ESICM President Elect

In 2007, the European Society of Intensive Care Medicine (ESICM) will celebrate 25 years since it was founded in Geneva in 1982. To mark this anniversary, the Society's Annual Congress in Berlin this year will combine the special celebrations with an exciting and novel scientific programme.

ESICM's Annual Congress has, over the recent years, been going from strength to strength. Each year, the number of attendees is growing with a total of over 6,000 participants contributing to last year's successful event in Barcelona. The Society's meeting is rapidly becoming the main event in the world for the presentation of research pertinent to critical care. Last year, there were over 1,400 abstracts submitted for presentation at the meeting. This year, a similar number is expected. The emphasis that ESICM puts on the presentation of novel research data and the time allotted to the debate of this topic allows not only young researchers to develop their skills, but also more established names to extol their theories. We believe that this open environment on the one hand provokes interesting and fruitful discussion and on the other hand, that it helps to improve our understanding of the practice of critical care and the new theories and developments that emerge constantly.

Prior to the meeting this year, there will be a number of pre-congress courses. These will cover topics such as echocardiography, weaning from mechanical ventilation, sepsis, disaster medicine, and stress metabolism. There will also be a 'refresher' course, designed to cover all the basics of critical care in a day and a half, with the aim of both educating towards the European Diploma and providing updated information to the more senior members of our specialty. These courses are often very popular and usually sell out quickly, so it is worth booking your place well in advance.

Furthermore, this year, the main programme has been designed to reflect the progresses and innovations relevant to intensive care medicine as a specialty that has grown and matured over the last 25 years and has become an established, relied upon and respected part of hospital medicine. To recognise recent developments, as well as past advancement, the congress will follow a thread on fourteen of the most significant topics pertinent to these changes. This will allow attendees, if they wish, to update their knowledge on all the major advances of our specialty. In order to recognise the achievements of the last 25 years, all attendees will also be presented with the book *25 Years of Progress and Innovation* by the most senior members of the Society regarding the changes and current concepts that would be discussed at the meeting.

Throughout the three-day congress, there will be ten parallel sessions contributing to a comprehensive overview of critical care medicine. These sessions will provide a mixture of 'state-of-the-art' data, professional development, clinical challenges and core competencies. They will cover virtually every topic relevant to our specialty and will give attendees the opportunity to acquire new information not only on the basics but also on the modern theories and controversies of our field that are still widely disputed. An outstanding international faculty will represent all corners of the globe and will be able to provide insights, opinions and debates that we can all learn from.

Celebrating our anniversary whilst providing a programme, designed to maintain the highest standards of scientific excellence and education, will become a powerful combination. In addition to this, visitors will also be able to sample the cultural and social delights on offer in Berlin. This should make for an exciting and popular meeting this year and we look forward to welcoming you at the opening ceremony. ■

20th annual congress

European Society of Intensive Care Medicine

Berlin, Germany
7 - 10 October 2007

For physicians, nurses and other allied healthcare professionals

Abstract submission deadline
15 April 2007

20TH ANNUAL CONGRESS

BERLIN 2007

EUROPEAN SOCIETY OF INTENSIVE CARE MEDICINE

25 YEARS OF PROGRESS AND INNOVATION

For more information, contact
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www.esicm.org

Agenda

JUNE 2007

9-12 Euroanaesthesia
Munich, Germany
www.euroanaesthesia2007.com

24-28 5th World Congress on Pediatric Critical Care
Geneva, Switzerland
www.pcc2007.com

SEPTEMBER 2007

5-8 3rd International Congress on Sepsis Multiorgan Dysfunction
Weimar, Germany

13-15 4th International Emergency and Rescue Congress
Hamburg, Germany
http://www.internationaler-kongress.de/

26-29 Sepsis 2007 International Symposium
Paris, France
www.sepsisforum.org

OCTOBER 2007

4-6 Emergency Medicine in the Developing World
Cape Town, South Africa
mcollin@curie.uct.ac.za

7-10 20th Annual Congress of the European Society of Intensive Care Medicine (ESICM)
Berlin, Germany
www.esicm.org

14-16 5th International Meeting on Intensive Cardiac Care
Tel Aviv, Israel
www.isas.co.il/cardiac-care2007/

18-20 3rd International Baltic Congress of Anaesthesiology and Intensive Care
Vilnius, Lithuania
www.anestez2007.com

25-28 ANZICS ACCCN 32nd Australian and New Zealand Intensive Care Annual Scientific meeting, incorporating the 12th Australian and New Zealand Paediatric and Neonatal Intensive Care Conference
Rotua, New Zealand
www.intensivecareasm.com.au

NOVEMBER 2007

18-21 Pan American and Iberian Congress of Critical Care and Intensive Therapy
Punta del Este, Urugruay
Mctiuruguay2007@personas.com.uy

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

FEBRUARY 2007

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

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

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

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	Overseas	65 Euros
Two years	Europe	85 Euros
	Overseas	100 Euros

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