ICU MANAGEMENT

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AFTER ICU

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- Early Enteral Nutrition in Trauma Patients: A Change Management Perspective on a Novel Meta-Analysis
- Expert in Pharmacokinetics of Antibiotics? Take our Masterclass
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AFTER ICU

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One of the most positive components of our roles in intensive care is that on any given day we are privy to real-life dramas wherein patients, who often enter our units with low scores and little hope of survival; endure, fight, recover and ultimately move to the wards or leave hospital. These stories are inspiring, and rewarding, and they remind us why we have chosen the field of critical care medicine.

The dark side, however, comes after our heroic patients leave the shelter of the ICU and the hospital, and attempt to return to work and rebuild their lives. Up until recently, few studies and little data was available on these patients' long-term outcomes and quality of life. Over the past decade, a number of initiatives have been set up by colleagues eager to fill this crack in the chain of care and consequently more emphasis has been placed on pushing beyond the starting point of post-ICU mortality rates onto functional status and quality of life (QOL) measurements. Additionally, further focus and scrutiny is being placed on the use and duration of interventions, namely ventilation and sedation, as well as early mobility protocols and their impact on the long-term outcome of patients.

In this issue of ICU Management, Dr. Bara Ricou and her team in Geneva provide us with an outlook of patients after they are discharged from intensive care. They describe both physical and non-physical impairments that patients suffer, and often fail to report and suggest early strategies that can be followed to lessen these long-term impacts.
Many of us may have heard of, or even considered implementing a "diary programme" in our own units, based on recent studies showing favourable long-term outcomes in patients who have participated. Dr. Christina Jones and Carl Bäckman, CCRN share their wealth of experience from running diary programmes in the UK and Sweden. They offer a point-by-point checklist on what is needed to implement a programme within your unit, and share details of their own multi-centre study.

Finally, we take a look at two initiatives out of the UK that are set on improving long-term outcomes for patients leaving the ICU: The ICON study and the iCanuk aftercare programme.

In the "Advances in Mechanical Ventilation" section we focus on non-invasive ventilation utilising the helmet. Dr. Massimo Antonelli and his more than capable team outline the characteristics, advantages and disadvantages of, as well as the physiologic aspects of NIV delivered by the helmet.

Change management is a concept which has bounced around our field in recent years. Dr. Gordon Doig and his esteemed colleague from Sydney, Australia tackle it again in a very practical manner in their feature entitled "A Change Management Perspective on a Novel Meta-Analysis: Early Enteral Nutrition in Trauma Patients".

If you are hoping to bone up on or perhaps simply re-acquaint yourself with antibiotic pharmacokinetics, Drs. Pereira and Povoa provide a masterclass on the topic, flush with advice on whether we can use pharmacokinetics to guide antibiotic therapy.

Rounding out our features is a look at the long-term outcomes of patients following adominal compartment syndrome, provided by experts Dr. Michael Cheatham and Karen Safcsak, RN. They highlight recent data that proves that, indeed, earlier recognition and appropriate intervention in patients at risk for IAH/ACS significantly increases patient survival, improves long-term functional outcome, and reduces hospital resource utilisation.

Recent tragedies at concerts in the US and here in Belgium remind us that no city or community in any country is immune from the dangers (be they weather or crowd-induced) that accompany public events. In our management section, we focus on preparation for such events with a look at an innovative template, which has been utilised and adapted to estimate healthcare resources for any given event.

In our country focus on Ireland, Director Damien McCallion delivers a detailed report of the state and overall outlook of healthcare while Drs. O'Brian and Phelan team up for a surprisingly positive description of intensive care medicine. Despite the existence of two healthcare systems on the island of Ireland, the authors depict an enviable unity of purpose within the critical care community (both north and south), which has paved the way for collaborative efforts in continuing education, research, training systems and examinations.

ESICM President Jean-Daniel Chiche likens our roles in the ICU to those of F1 race car drivers in our Viewpoints section. In highlights taken from his interview with Managing Editor Sherry Scharff, he also details the inspiration behind the LIFE campaign and underscores the importance of connecting with our patients; not only within the walls of the ICU but also beyond them.

It is generally accepted that many survivors of critical illness will continue to suffer physical, psychiatric and overall quality of life impairments long after they are discharged from intensive care. As practitioners, our responsibility to these patients begins at their arrival in our units and carries on long after their discharge. Adapting interventions and identifying patients who are a heightened risk of developing long-term complications are key management strategies in our goal of improving long-term quality of life outcomes for our most vulnerable patients.

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IN MEMORIAM

Dr. Max Harry Weil

If ever a doctor deserved the title of "Father of Critical Care Medicine", it is Dr. Max Harry Weil, MD, PhD, ScD (Hon). Concerned by the lack of close monitoring of critically ill patients, in 1958 Dr. Weil developed the famous Shock Unit at the University of Southern California. He was always an innovator, full of new ideas, and passionate about his subject. His contributions to critical care medicine are too many to be listed, but he changed the very basics of how critically ill patients are approached and managed. Much of what we do on a day to day basis is down to Max Harry Weil: Our understanding of the pathophysiology of shock states and pulmonary oedema, of blood lactate levels, of fluids and vasoactive support in shock; the monitoring systems we use; techniques of cardiopulmonary resuscitation (CPR), …the list goes on. Dr. Weil brought together medicine, physiology, pharmacology, biochemistry and bioengineering for the benefit of the patient.

Dr. Weil was a founding member and the first President of the Society of Critical Care Medicine. He published more than 600 original articles and reviews, held more than 20 patents, and received awards and honours from many of the major critical care and emergency medicine societies and associations. Over the years he helped mentor many intensivists from around the globe, and we have all benefited from the quality of that training. He was a sought after speaker at meetings worldwide, including the ESICM annual symposium at which he participated on several occasions.

A caring, thoughtful, brilliant man, Dr. Weil will be deeply missed by us all, but will never be forgotten.

JL Vincent / *06 August 2011*

RESEARCH NEWS

Statins Reduce Deaths from Infection and Respiratory Illness, Data Eight Years On from Trial Suggests

The death rate among patients prescribed a statin in a major trial that ended in 2003 is still lower than those given a placebo, even though most participants in both groups have been taking statins ever since. ASCOT, the Anglo-Scandinavian Cardiac Outcomes Trial, was stopped early because the statin was so effective at preventing heart attacks and strokes, but a new analysis has shown that eight years on, the most significant difference between the groups is a reduction in deaths from infection and respiratory illness. The latest findings, from researchers at Imperial College London, were presented at the European Society of Cardiology Congress in Paris August 28 and simultaneously published in the European Heart Journal.

In the lipid-lowering arm of the trial, over 10,000 patients in the UK, Ireland and Scandinavia with high blood pressure were randomly allocated either atorvastatin or placebo between 1998 and 2000. In 2003, the trial was stopped early because the statin proved to be highly beneficial in preventing heart attacks and strokes. Since then, most participants from both groups have been taking statins.

The new analysis looked at the number and cause of deaths among the 4,605 participants in the ASCOT trial who are based in the UK. After 11 years' follow-up, overall mortality is 14 percent lower in the group originally assigned atorvastatin, due largely to fewer deaths from infection and respiratory illness.

"This result is very unexpected," said Professor Peter Sever, from the International Centre for Circulatory Health at Imperial College London, who led the study. "The benefits of statins for preventing heart attacks and strokes are well-established, but after long-term follow-up the most significant effects seem to be on deaths from other causes. It's quite remarkable that there is still this difference between the two groups, eight years after the trial finished. "Some studies have suggested that statins protect people against death from infectious diseases such as pneumonia. More research is needed to explain how these drugs might have unforeseen actions that prevent deaths from other illnesses."

Amongst UK participants, in the 11 years since the trial began, 460 of the original statin group have died, compared with 520 of the placebo group. The difference is largely explained by a 36 percent reduction in deaths from infection and respiratory illness. Deaths from cardiovascular disease were also lower in the original statin group, but the difference was not statistically significant. There was no difference in deaths from cancer.

The study was investigator-led with funding provided by Pfizer. Professor Sever is a National Institute for Health Research (NIHR) Senior Investigator and he was supported by the Comprehensive Biomedical Research Centre award to Imperial College Healthcare NHS Trust, from the NIHR.

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Journal Reference:

P.S. Sever et al. *The Anglo-Scandinavian Cardiac Outcomes Trial: 11 year mortality follow-up of the lipid-lowering arm in the UK.* European Heart Journal, 2011 DOI: 10.1093/eurheartj/ehr333

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Experience of repeated administration of Simdax is limited. Experience with concomitant use of vasoactive agents, including inotropic agents (except digoxin) is limited.

Monitoring of treatment: Consistent with current medical practice, ECG, blood pressure and heart rate must be monitored during treatment and the urine output measured. Monitoring of these parameters for at least 3 days after the end of infusion or until the patient is clinically stable is recommended. In patients with mild to moderate renal or mild to moderate hepatic impairment monitoring is recommended for at least 5 days.

Elderly: No dose adjustment is required for elderly patients.

Renal impairment: Simdax must be used with caution in patients with mild to moderate renal impairment. Simdax should not be used in patients with severe renal impairment (creatinine clearance <30 ml/min).

Hepatic impairment: Simdax must be used with caution in patients with mild to moderate hepatic impairment although no dose adjustment appears necessary for these patients. Simdax should not be used in patients with severe hepatic impairment.

Children: Simdax should not be administered to children and adolescents under 18 years of age.

Contraindications
Hypersensitivity to levosimendan or to any of the excipients. Severe hypotension and tachycardia. Significant mechanical obstructions affecting ventricular filling or outflow or both. Severe renal impairment (creatinine clearance <30 ml/min) and severe hepatic impairment. History of Torsades de Pointes.

Special warnings and special precautions for use
An initial haemodynamic effect of levosimendan may be a decrease in systolic and diastolic blood pressure, therefore, levosimendan should be used with caution in patients with low baseline systolic or diastolic blood pressure or those at risk for a hypotensive episode. More conservative dosing regimens are recommended for these patients. Physicians should tailor the dose and duration of therapy to the condition and response of the patient.

Severe hypovolaemia should be corrected prior to levosimendan infusion. If excessive changes in blood pressure or heart rate are observed, the rate of infusion should be reduced or the infusion discontinued.

The exact duration of all haemodynamic effects has not been determined, however, the haemodynamic effects, generally last for 7-10 days. This is partly due to the presence of active metabolites, which reach their maximum plasma concentrations about 48 hours after the infusion has been stopped. Non-invasive monitoring for at least 4-5 days after the end of infusion is recommended. Monitoring is recommended to continue until the blood pressure reduction has reached its maximum and the blood pressure starts to increase again, and may need to be longer than 5 days if there are any signs of continuing blood pressure decrease, but can be shorter than 5 days if the patient is clinically stable. In patients with mild to moderate renal or mild to moderate hepatic impairment an extended period of monitoring maybe needed.

Simdax infusion should be used cautiously in patients with tachycardia atrial fibrillation with rapid ventricular response or potentially life-threatening arrhythmias.

Interaction with other medicinal products and other forms of interaction
Consistent with current medical practice, levosimendan should be used with caution when used with other intravenous vasoactive medicinal products due to a potentially increased risk of hypotension.

No pharmacokinetic interactions have been observed in a population analysis of patients receiving digoxin and Simdax infusion. Simdax infusion can be used in patients receiving beta-blocking agents without loss of efficacy. Co-administration of nesiritide mononitrate and levosimendan in healthy volunteers resulted in significant potentiation of the orthostatic hypotensive response.

Undesirable effects
The most commonly (>1/10) reported adverse reactions include headache, hypotension and ventricular tachycardia.

Overdose
Overdose of Simdax may induce hypotension and tachycardia. High doses (at or above 0.4 microgram/kg/min) and infusions over 24 hours increase the heart rate and are sometimes associated with prolongation of the QTc interval. Simdax overdose leads to increased plasma concentrations of the active metabolite, which may lead to a more pronounced and prolonged effect on heart rate requiring a corresponding extension of the observation period.

Storage
Store at 2°C-8°C (in a refrigerator). Do not freeze.

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AFTER ICU

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Introduction

Intensive care medicine is quite a recent medical discipline born around 1950. At the beginning, the medical world held an illusion that new highly sophisticated techniques would allow for the recovery of every single patient. A half century later, the discipline has grown up and there is a realisation that while many more lives can be saved and obviously fewer patients die, the many patients who survive do so with variable degrees of disability; some acceptable, and some less acceptable and unforeseen until recently (Figure 1). Additionally, Intensive Care Units (ICU) are scarce resources that represent a large part of national health expenditure and hospital budgets. ICU costs are growing and represents between 0.5 to 1% of the gross domestic product (Halpern and Pastores 2010).

Because ICU costs are important and outcomes may be poor, the aim of intensive medicine should be directed towards outcomes that could be considered more satisfactory to patients and societies' perspectives. More than ICU mortality, long-term survival and patient-centred outcomes, such as functional status or Quality Of Life (QOL) should be considered and advised to be sought (Angus and Carlet 2003). Among all critically ill patients, elderly or chronic critically ill patients are especially prone to develop unsatisfactory outcomes.

The aim of the present article is to describe some of the major difficulties encountered by the patients after their stay in ICUs. Many of these difficulties are under reported, since patients and their relatives are so grateful towards the ICU caregivers that they would not dare to complain. However, the literature now shows evidence that there is room for improvement in their management and the targets start to be known.

Outcome after ICU: General Considerations

Mortality can be described in different ways: ICU, hospital or follow up mortality. There are multiple studies that are difficult to compare, because ICU or hospital mortality depend on the organisation or structure of the hospital and can differ among types of ICUs, hospitals and even countries (e.g. University vs non university; paediatric vs adult ICU; general ICU vs specific ICU; presence of intermediate care or lack of), as well as the case-mix and the timing of the mortality assessment. Review articles describe ICU mortalities ranging from 8 to 33%, hospital mortalities from 11 to 64%, one-month mortalities from 15-21% and follow-up mortalities at 12 months after ICU ranging from 26 to 63%. Generally the most common mortality data used is the hospital or "28/30 day" mortality. Only recently have ICU managers begun to focus their attention on long-term mortality. Interestingly, mortality can be assessed at four different moments (Figure 2). After discharge from the hospital, there are still further deaths (the after-hospital excess mortality). Compared to an age- and gender-matched population, higher mortality persists up to 15 years after ICU discharge. The factors associated with one- year mortality are:

- Older age;
- Presence of co-morbidities;
- Presence of a new malignancy;
- Admission diagnosis;
- ICU admission severity, and
- The number of organ failures during ICU stay.

Additional factors, such as male gender and ICU length of stay are associated with an increased mortality up to 15 years after ICU discharge (Williams et al. 2010). Emergency admissions, functional status and the QOL before ICU admission may also impact on after-hospital mortality.

The morbidity after ICU can be divided three main fields: Physical, non-physical and other impacts.

Physical Impairments

The physical impairment can be addressed through specific organ dysfunctions or by a general assessment of the status using validated instruments. Studies indicate that the functional

status is already lower before ICU admission compared to an age- and gender-matched population (Hennessy et al. 2005). After ICU, functional status is similar to or only slightly reduced from status before ICU in two-thirds of patients. A great majority of patients will not need any help after ICU discharge. However, there may be huge differences between patients, depending on ICU admission diagnosis. Organ specific functional status is often assessed by instruments and is not explicitly developed for critically ill patients; therefore their reliability sometimes has to be questioned. Respiratory problems may persist, especially in ARDS patients, even after 24 months, with chronic dyspnea or sequelae from tracheotomies (Herridge et al. 2003). Polyneuropathies, weight loss and sexual dysfunctions may affect critically ill patients for years after ICU (Flaatten 2007).

Non-Physical Impairments

Concerning non physical impairments, up to 50% of ICU patients suffer pain after ICU (Boyle et al. 2004). Cognitive disorders are described in half of the general, and in up to three-quarters of an ARDS population. Half of ICU patients may suffer depression, delusional memories, panic attacks or insomnia (Granja et al. 2005; Flaatten 2007). Post-traumatic disorders have been described in 5-64% of patients, depending on the instrument used and on the type of patients included (Davydow et al. 2009a; Davydow et al. 2009b). Younger age, male gender, traumatic and delusional memories of the ICU as well as previous depression seem to be risk factors associated with their occurrence. The QOL of ICU patients is already reduced before ICU admission, as is functional status when compared to an age- and gender-matched population. After ICU, most patients regain their pre-ICU QOL in 6-12 months. ARDS and traumatic brain injury patients may take up to 24 months to stabilise and regain pre-ICU QOL. Even elderly patients seem to recover as fast as younger ICU patients (Hennessy et al. 2005).

Other Impacts

If we look at other outcomes, we have to emphasise that 75-90% of patients surviving ICU, even the older ones, will be able to go back to their homes within 12 months after ICU (Conti et al. 2011). Up to 60-80% of the previously working population who survived will be able to go back to their work, however, ICU admission diagnoses play a role in the differing results. There is very little data regarding other areas of major life events, such as divorces, violence, and economic strains after ICU. Such fields also directly address patient-centred outcome and may warrant more interest in future studies.

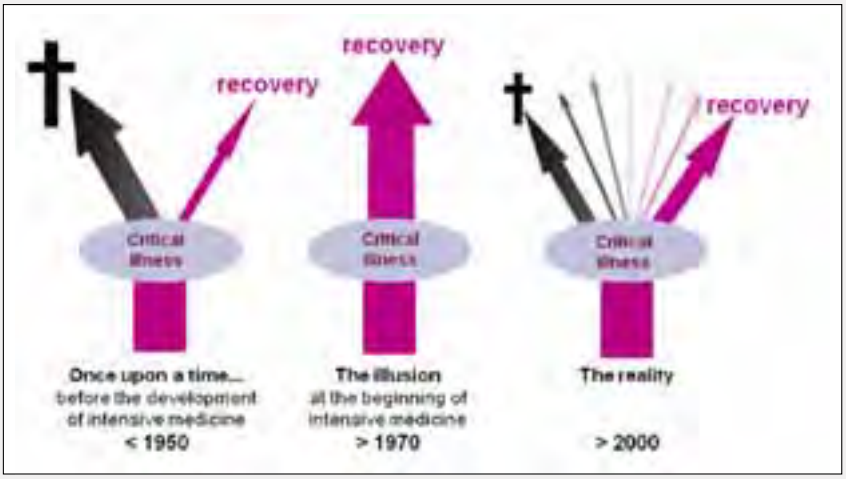

Figure 1: The dream of the intensivist
Schematic summary of the public and physicians' expectations of intensive medicine throughout the years. From a joint reflection between Alexander Mauron, bioethician and Bara Ricou, intensivist. Bioethics Unit and Intensive care Unit, University of Geneva, Switzerland.

Chronic Critically Ill

Chronic critically ill or long-term ICU patients are often defined according to their length of stay. These LOS guidelines often differ:

- More than 96 hours (Zilberberg and Shorr 2008),
- More than 7 days (Weissman 2000),
- More than 28 days (Estenssoro et al. 2006) or
- More than 30 days (Friedrich et al. 2006).

They can also be conceptually defined as patients who survive the acute phase and who remain dependent on the ICU technology and skills. For the last decade, probably due to the increasing proficiency of intensive medicine, this population has grown rapidly, whereas the number of patients reaching hospital discharge did not increase as much (Zilberberg and Shorr 2008). In our institution, patients remaining in ICU for more than 7 days had higher ICU and hospital mortality (17 and 34 % respectively). On a three-month follow-up, a third of these patients had died, another third remained in hospital longer or were institutionalised (personal unpublished data), but the good news is that a third could return home. Although the survival rate seems lower than for general ICU population, chronic critically ill patients seem to achieve a long-term quality of life that seems similar (Stricker et al. 2005). However the amount of knowledge regarding this population remains poor.

Elderly Patients

Occidental countries are characterised by a demographic aging. The proportion of elderly patients is also growing in ICUs. This growing patient group consumes more than half of all ICU days (Pronovost et al. 2001). Elderly patients represent a peculiar population since they are more prone to develop chronic diseases such as diabetes, hypertension or atherosclerosis. This biological aging progresses in a continuum leading to the development of the frailty syndrome (Inouye et al. 2007). Therefore elderly patients may have a limited physiological reserve and their capacity to heal may be

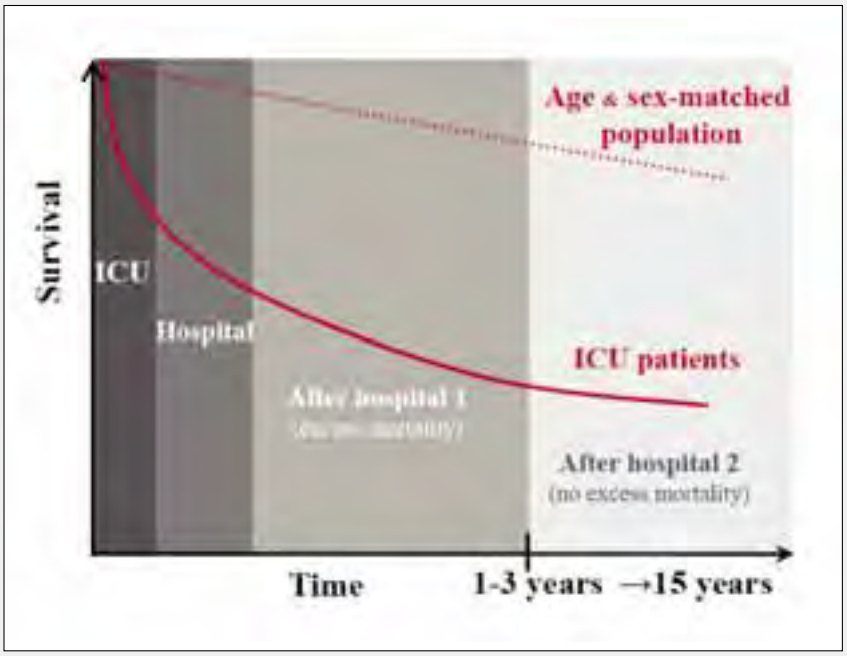

Figure 2: Mortality after ICU
Four different "mortality" moments can be observed: ICU mortality, hospital mortality, first after-hospital mortality (with an excess mortality compared to an age- and gender-matched population) and a second after-hospital mortality (with no excess mortality compared to a matched population). Excess mortality is underlined in the figure by the fact that the mortality curve of ICU patients has a steeper slope than the age and gender matched population. In the "after hospital 2" period the two curves become parallel, meaning absence of excess mortality. Recent data suggest that the excess mortality after ICU may persist well beyond 1-3 years, and that it may last even 15 years. (Adapted and modified from (Flaatten 2007)).

somewhat altered, resulting in less favourable outcome than that of younger patients after an acute severe illness.

Depending on the definition of elderly patients and after correction of confounding factors, chronological age itself has a limited effect on mortality (Boumendil et al. 2007). However, when elderly patients survive ICU, they remain at a high risk of death especially during the first months (Kaarlola et al. 2006).

Besides mortality, the two major determinants to predict long-term outcome for the elderly population are the condition of the patient at the completion of their ICU stay and their QOL. As for the mortality, the data are difficult to interpret and subject to a pessimistic or optimistic point of view (Hennessy et al. 2005). The functional status is obviously diminished after an ICU stay, whereas the self-reported QOL seems to be as good as similar-age general population (Ricou and Merlani 2008). Their recovery rate seems not longer than that of younger patients (Capuzzo et al. 2006).

Finally some studies about elderly patients' preferences regarding their outcome after ICU seem to suggest that the most unsatisfying issue for them is a discharge to a nursing home. Most patients are "very unwilling" or "would rather die". Although many suffer of a decreased functional status, most of the elderly ICU survivors are able to go back to their home and most, relatively rapidly after their hospital discharge (Conti et al. 2011).

What Can Be Done in ICU to Improve Long-Term Outcomes After ICU?

Two main axes seem to offer possibilities of action to improve the QOL after ICU, namely: physical strength and neuropsychological recovery. Increased care for adequate nutrition decreases the length of mechanical ventilation and ICU stay and may shorten the recovery phase (Thibault and Pichard 2010). Long-term mortality and prolonged physical impairment are closely related to the ICU acquired paresis that may be prevented or treated earlier during the ICU stay by precocious mobilisation and careful nutrition (Merlani 2008). Neuropsychological outcomes such as post traumatic stress disorder impact heavily on patients' QOL (Granja et al. 2005). Related associated factors such as prolonged sedation and physical restraints seem to offer some targets to improvement, as do the utilisation of intensive care diaries (Jones et al. 2010).

Conclusion

There are numerous unrecognised or underestimated problems after ICU regarding physical and psychological recovery, as well as family, social, employment and housing aspects. However, given the present state of knowledge, prevalence is given to focus on the two main axes for improving life after ICU: Attempting to increase physical strength and support neuropsychological recovery. Further studies are clearly needed to extend our knowledge about other aspects of patients' long-term outcomes, so that strategies to affect and improve these issues can also be incorporated into future recovery plans. ■

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IMPLEMENTING A DIARY PROGRAMME IN YOUR ICU

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Patients recovering from serious illness have been shown to be at risk for developing Post Traumatic Stress Disorder (PTSD). Studies show that around 1 in 10 patients with an ICU stay of 48 hours or more develop PTSD (Jones et al. 2007).

Since the 1980s, it has been known that patients don't tend to remember much from their time in ICU and as doctors and nurses we thought that was good. If patients asked questions about their stay they might be told "Don't worry about that, look forward now and you will be better as time goes on." It was also believed that relatives could answer the patients' questions.

We now know that most of our patients really want to know what happened during their stay and that relatives need assistance in explaining the course of their ICU-stay, because this a very chaotic time for them too and their memory might be influenced by anxiety, depression and sleep problems. As a result, these patients can spend a lot of time thinking about what really happened, and become confused by the mingling of reality and dreams, often relating disturbing "memories" of people being killed or injured.

The Diary Projects

The diary projects at Norrköping (Sweden) and Whiston (UK) hospitals started in 1995

» Continues from p.9

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Patient is critical, after perforated diverticulitis

Patient's circulation remains very unstable, requiring a continuous team of staff.

Patient is in recovery; wife visits him (note the paintings done by grandchild on the walls).

Patient returns for follow-up visit.

Photos Courtesy of Patient Björn Roback; ICU stay 49 days

and 2002, respectively. The aim of both projects was to recreate the time in ICU for patients and their relatives. This was done by writing and taking photographs of the patients during their ICU stay and then, after one or two months, inviting the patient together with their family to return for a follow-up meeting. At Norrköping, we originally got the idea of writing diaries from a group of nurse assistants, led by Annelie Unosson from Danderyds Hospital, Stockholm. It was only later that we discovered that diaries had been used in Norway (Schou in Sygeplejjen, 1984).

We wanted to make the diaries a part of a larger concept; not only writing about the patients' ICU stay but also taking photographs of significant events and including them in the pages. To achieve this, we had to understand how patients and families felt about these very realistic pictures. In addition, we also needed their evaluation of this whole intervention.

Impact

In our follow-up study which included both centres, patients and relatives reported feeling that the diary was a good idea and that the photographs helped to complete the story (Bäckman and Walther 2001). Here are some of the comments made:

From Patients:

- The diary helps me to understand what I have gone through and I think the idea of having photos and text together is a very good idea.
- By having the diary to show to friends and acquaintances, I find they gain a better understanding. The photos and text provide a complete picture that is difficult to communicate in any other way.
- It has helped us to understand what went on during the time we spent in Intensive Care – something that is difficult when you are in the midst of it all. A valuable document which we will have use for the rest of our lives.

From the Relatives:

- During the time following my friends' ICU stay, I used to carry the diary with me everywhere. Whenever a question came to me, I had something concrete to refer to. He was very proud of his diary and use to talk a lot about it.
- It is obvious to me that a diary like this should be a routine part of Intensive Care.
- It felt good to be able to express in words the feelings of loss and sadness, thoughts that passed my mind, things I wanted to tell Dad. It was also important for us close relatives to read about Dad's daily life in Intensive Care and to read how you, the staff, helped him when we were not there.

In a separate study on the impact of ICU diaries on the incidence of PTSD, patients were also asked to give personal comments about diaries (Jones et al. 2010). The study showed that the incidence of PTSD was reduced from 13% down to 5% in those receiving the diary.

Feedback about the diaries was very positive with most of the intervention patients receiving the diary at the one month follow-up and reading it a median of three times (0-20 range), only one patient had not read the diary.

148 (84%) of the intervention patients said that others had read the diary, most commonly family (100%), friends (36%), colleagues (5%) and healthcare staff (4%). When asked what

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the intervention patients felt helped most only two (1.4%) patients mentioned the meeting with the nurse, while 66 (49%) felt reading the text in the diary was most helpful, 49 (36%) the combination of photographs and text and 21 (15%) the photographs.

Implementing the Diary Concept

The concept includes four important steps

1. Starting a Diary

Consent
Where possible it should be explained to patient and their relatives that staff are going to create a tool (the diary) during the ICU-stay that is meant to be used during recovery both for patients and relatives. At Norrköping, we often start the diary before we get their consent (often from the relatives when the patient is too sick) to write and take photos, make sure that the relatives know that they are also allowed to write. At Whiston, the diaries are explained to the family and the patient (where possible) as a standard therapy and assent/consent is not sought. The patient gives written, retrospective consent once they are well enough to receive the diary.

Documentation
Start the diary by making a summary of what happened to bring the patient into ICU and why it was needed. Write in everyday language in a realistic way and where possible the staff and relatives should write something everyday, if the stay is very prolonged you don't have to write so often. At Norrköping the diary, without photos, follows the patient to the ward so that staff and relatives and sometimes the patient themselves can write about life on the general ward.

2. Taking Photographs

Take a photograph on the day the diary is started and then at points of change in the patients' condition. The pictures should not be intrusive but realistic, don't be afraid of getting close to the patient, they need to be able to recognise themselves. It is important to include staff and relatives in the photographs where possible, as the patient may not remember anything but hallucinations or nightmares.

3. The Follow-up Meeting/ Going Through the Diary

At Norrköping, we call the follow-up meeting "The golden meeting" when we can have a two-way conversation, giving the patient a chance to ask about things that they may not be sure really happened. We can ask the patient and relatives how they felt they were taken care of and how the relatives experienced the ICU stay. This is a situation where we as staff can learn a lot about how closely we are meeting their needs. Nowadays we have this meeting at our follow-up clinic, which is run by two ICU nurses together with two nurse assistants, all of them working in the ICU.

At Whiston the patient often receives the diary before they go home from hospital at a point they feel comfortable with going through it. Their family are encouraged to be there at the meeting. Opportunity is given for questions and information given about recovery from critical illness both verbally and in a written form using the ICU Recovery manual (Jones et al. 2003). Patients will then be called back to the follow-up clinic at 2-3 months post ICU discharge to make sure there are no issues remaining that need to be addressed.

> *"The study showed that the incidence of PTSD was reduced from 13% down to 5% in those receiving the diary."*

4. Evaluation of the ICU-Diary Concept

The evaluation includes the diary, the photos and the follow-up meeting. At Norrköping the patient is sent a questionnaire allowing them to anonymously evaluate the whole intervention. At Whiston the patient and their family are asked directly at the follow-up clinic if they feel the diary and photographs are helpful and if there is anything they would like done differently. The evaluation gives the staff the opportunity to improve the concept.

How to Implement a Diary Programme in your ICU

What you need:

- **DIARY GROUP** - Assemble a diary-group which contains of staff who are very interested in this area of ICU. At Norrköping we have had a mixed group of six people, including nurses, nurse-assistants and the occasional doctor. At Whiston, it is made up of nurses of different grades.

- **BOOKS** - Acquire some books that can be used as a diary. In Norrköping, we use a A5 lined notebook while at Whiston, we use a spiral bound A5 lined notebooks with a clear plastic cover which can be wiped clean as they are kept at the patients bedside in ICU.

- **CAMERA** – Find a digital camera with (simple) instructions how to use it. In Norrköping the staff from the follow-up clinic once a month moves the photos from the camera to a memory stick which is kept in a locked drawer at the follow-up clinic. The photos are collected in "personal boxes", one for each patient. Before the one/two month follow-up meeting, these photos are printed out on plain paper so they easily can be pasted in the diary. Patients are also able to retreive their photos from the "personal box" on a memory stick. At Whiston, the legal department has directed that

AUTHOR GUIDELINES

ICU MANAGEMENT

Content

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

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

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

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

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

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

Thank you,
The ICU Management Editorial Team
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the photograph must be printed out straight away and the original deleted from the memory card so that there are no copies. The photographs are kept in a locked drawer in the ICU offices until they are placed in the diary after the patient has given retrospective consent. We also only use plain paper rather than photographic paper to print out onto as it is easy to paste into the diary at the appropriate place when the patient receives the diary.

- **GUIDELINES** - Guidelines for writing the diaries should be designed by the diary group and made readily accessible. These should cover the reasons for doing the diary, the kind of things that should be written and how the diary should be looked after. For an example of diary guidelines see Jones et al. 2010

- **INFORMATION SHEET** - In Norrköping we inform the relatives that we have started or shall start a diary and take pictures. We explain that we have done this for more than 15 years and different studies have proven that it is helpful for both patients and relatives. At Whiston, we have an information sheet for relatives which explains about the diary, encourages them to write in it themselves and contains some suggestions about what they could write about.

- **CONSENT FORM** - At Whiston, we have a retrospective consent form that the patient signs to say they are happy to keep the diary and photographs. A copy of this is filed in the hospital notes.

- **FOLLOW-UP MATERIALS** – It may be useful to provide an information book about recovery from critical illness. At Norrköping this is given to the patient before they leave the hospital along with verbal and written information about being invited back after one or two months with relatives/friends. When it's time for follow-up, one of the staff from the follow-up clinic contacts the former ICU-patient (who often is back home) and a meeting is scheduled, and then confirmed by post. Together with the written invitation we also send a questionnaire (SF-36) to be filled in when coming to the meeting. The SF-36 (Ware and Sherbourne 1992) is a questionnaire that deals with Health Related Quality of Life and that we ask our patients to fill it in at two, six and 12 months to investigate how their Quality of Life changes as time goes by. At Whiston, the ICU Recovery Manual is provided after the patient has moved to the general wards. An invitation for an outpatient appointment (with their family) within two to three months post-ICU discharge is forwarded by post.

- **PRIVATE MEETING SPACE** - At Norrköping we have a special room for the follow-up meeting. At Whiston, this is done at the patients' bedside on the ward or in the ward office if the patient requests privacy.

- **TIME FOR THE FOLLOW-UP MEETINGS** - At Norrköping, we now have a follow-up clinic. Our diary group contains two nurses and two nurse assistants with a combined ICU experience of more than 100 years. Each person in the group has 24 hours per month available and they work in pairs (nurse + nurse assistant). The clinic is open on Thursdays (closed during summer) and every patient that has had an ICU stay of more than four days is followed-up, even if they don't have a diary. Patients also visit the ICU as part of the follow-up visit. At Whiston, the patient is followed up on the general wards as part of the rehabilitation programme and told about the diary. They then choose when they would like to go through the diary and a meeting is organised, usually on the ward before they go home. A visit back to the ICU is offered at the outpatient clinic.

- **OTHER** - Diaries where the patient dies. At Norrköping, if a patient dies, the relatives are given the diary and the photos during a follow-up meeting arranged by the staff from the follow-up clinic. At Whiston, the family are contacted three weeks after the patients' death and offered the written part of the diary. The photographs can not be given to the family as the patients' written consent has not been obtained (UK law). ■

For full references of this article please contact **editorial@icu-management.org**

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IMPROVING LONG-TERM RECOVERY AFTER CRITICAL ILLNESS IN THE UK:
THE INTENSIVE CARE OUTCOME NETWORK (ICON) STUDY & THE INTENSIVE CARE AFTERCARE NETWORK – I-CANUK

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Background

Critical illness

Critical illness is any form of illness that represents an immediate threat to life. The major purpose of Intensive Care Units (ICUs) is to treat patients with potentially reversible forms of critical illness. Until recently, the major focus in ICU research has been on survival, usually short-term survival, and with modern day ICU treatment around 80% of critically ill patients survive to hospital discharge. However, attention is now moving from short-term survival to long-term outcomes and the process of long-term recovery after critical illness. Long-term recovery comprises physical performance, psychological function, and quality of life and Health Related Quality of Life (HRQoL), with the latter attempting to measure the overlap between health status and overall quality of life.

Critical illness – A growing and important public health problem?

Over 100,000 patients are admitted to ICUs in the United Kingdom (UK) per year. Of these over 40,000 are dead within one year of ICU admission (Cuthbertson et al. 2005). Over the five years after an ICU admission there is an excess risk of death when compared to an age and sex matched population (Wright et al. 2003). In the USA, six million individuals (2% of the population) are admitted to an ICU each year at a cost that exceeds 0.5% of Gross Domestic Product (over 100 billion US Dollars) (Halpern et al. 2004; Angus 2007). In the UK, the long-term outcome of patients that have experienced ICU treatment has been identified as a priority area by the Department of Health, acknowledged by the recent commissioning of a NICE guideline on the rehabilitation of survivors of critical illness (National Institute of Clinical Excellence, 2009).

Long-term survival after critical illness – What is known and what is not known?

The pattern, as well as determinants, of long-term survival following critical illness is now well described (Williams et al. 2008). Survival is worse in the first 6 to 12 months after discharge from hospital but, compared with age-, gender-, and era-matched members of the general population, survivors of critical illness have worse survival at all time points up to 15 years following ICU admission.

In contrast to survival, much less is known about the pattern and determinants of long-term recovery, but a few conclusions are consistent across existing studies. During post-discharge follow-up survivors have a markedly lower HRQoL than an appropriately matched general population. Over-time, HRQoL tends to gradually improve although it generally remains lower than the matched general population (Dowdy et al. 2005). There is a definite occurrence of PTSD after critical illness though the reported range of incidence is wide (5 to 64%) (Griffiths et al. 2007). Clinically significant depression appears to be common though the reported incidence is also wide (8 to 61%) (Davydow et al. 2009). Age, pre-existing co-morbidities, severity of illness, and pre-existing poor health status and HRQoL have all been reported to contribute to poor long-term outcomes (Williams et al. 2008).

However, although existing research has shown that ICU survivors experience an increased burden of psychological and physical illness following discharge, much of this literature is seriously flawed. The internal validity of existing studies is threatened by insufficient sample size to explore potentially relevant risk factors; insufficient duration of follow up to adequately describe recovery; selection bias related to high rates of loss to follow up, and inadequate adjustment, confounded by the fact that there are no studies that evaluate an adequate array of potential risk factors.

Despite the recognition that a number of ICU patients experience significant problems with physical, psychological, and social functioning for some time after discharge there is little research into the economic impact of this morbidity on the patient and their immediate family. The only available evidence in the literature comes from two studies undertaken in the USA (Covinsky et al. 1994; Swoboda et al. 2002). These studies reported that 34% of seriously ill hospitalised patients required considerable care-giving assistance from a family member in the 12-months following hospital discharge, and In 20% of cases, a family member had to quit work or make another major life change to provide care for the patient.

The continuing problems of ill-health and economic difficulty has implications not just for patients, but imposes a continuing financial burden for the National Health Service (NHS) in terms of primary and secondary healthcare costs. It also imposes a potential burden on society and the benefit system that ultimately is responsible for the provision of financial support. However, there is a current lack of evidence in the literature on the economic impact of critical illness on survivors and its associations with overall HRQoL to inform this and future policy.

The ICON Study and i-Canuk Network

The primary aim of the collaborators associated with the ICON study and i-Canuk network is to further describe the longer-term HRQoL and personal economic costs in a multicentre population of survivors of treatment in UK ICUs, thereby significantly contributing to existing research in this field.

The ICON Study

ICON is a large multicentre study involving nearly 30 UK ICUs that has recruited almost 30,000 patients over five years. This study employs a 24-month follow up period with HRQoL measures administered at 3, 12 and 24 months after ICU discharge. The study protocol has been previously published (Griffiths et al. 2008). Phase one of the ICON study has recruited approximately 9,000 patients and trialled a questionnaire pack containing the Short Form-36 (SF-36) and the EuroQoL (EQ-5D), the Hospital Anxiety and Depression Scale (HADS) and the PTSD Civilian Checklist (PCL-C). A major aim of phase one of the ICON study was to demonstrate the efficacy of postal paper-based follow up methodology. Phase two followed up a further 18,000 patients after ICU discharge and randomised them to receive one of two questionnaire packs comprising of different combinations of the above named instruments. Phase one recruitment commenced in late 2006 and is now complete up to 24 months following ICU discharge. Phase two recruitment is in the process of being replaced by phase three. Phase three will apply even tighter follow up protocols incorporating postal, telephone, fax, text/SMS and e-mail follow-up and an ever expanding patient tracking system.

The ICON study is now the world's largest registry of patients who have survived critical illness and will hopefully create a valuable UK database detailing the prevalence of physical and psychological morbidity experienced by patients as they recover from critical illness. Knowledge of the prevalence of physical and psychological morbidity in ICU survivors is important because research to generate models of causality, prognosis and treatment effects is dependent on accurate determination of prevalence. The results will also inform the economic modelling of the long-term burden of critical illness.

i-Canuk – The Intensive Care Aftercare Network

A national survey of post-ICU follow-up services in the UK was published in 2006 and demonstrated that at least 80 hospitals across the UK had developed post-ICU follow-up clinics in an attempt to improve outcomes after ICU discharge (Griffiths et al. 2006). This interest in the long-term outcome of survivors of ICU treatment in the UK fuelled the development the i-Canuk network with the following mission statement:

- Promote the role of ICU follow-up services;
- Provide a forum for those involved or interested in ICU follow-up;
- Encourage investigation of the scientific base of physical, psychological and social consequences of critical illness;
- Produce educational and multimedia resources;
- Form partnerships between multi-professional care givers, industry, academia and patients and their families;
- Support evaluation of therapeutic options to improve outcomes following critical illness;
- Support the establishment of evidence-based standards and guidelines for follow up services, and
- Facilitate a national minimum dataset of post-ICU outcome measures.

A grant from the department of health was obtained in 2009 to fund the first collaborative research project of the i-Canuk network. Mirroring some of the methodology of the ICON study, i-Canuk has undertaken a pilot study of the long-term economic impact of critical illness and its association with the HRQoL of patients discharged from ICUs in the UK. This study employs similar instruments to the ICON study - EQ5D and SF36v2 - together with a novel economics questionnaire designed to detect changes in household income and the level of financial and personal dependence amongst the patient's family and the health services. The study is designed to further understanding of the economic impact of ICU admission and treatment on HRQoL, and the patient's family life and the health service usage. 840 patients have been recruited from 20 UK ICUs sites over an 18-month period and the 24-month follow-up point was reached in April 2011

"the system has the ability to score and calculate the various instruments using the data returned by each individual patient… provides real time analysis (and) on the spot identification of those patients reporting significant signs of underlying psychological disease."

and analysis is underway.

For both these studies, collaborative work with the UK Intensive Care National Audit and Research Centre (ICNARC) has allowed the patients' acute illness to be accurately characterised using a number of descriptors based on the Critical Care Minimum Dataset mandatory elements that are routinely captured by every ICU in England.

Lessons Learnt from the ICON Study and i-Canuk Study

To make long-term follow-up studies cost effective it is essential that study expenditure per patient remains as low as possible. The availability of a high quality national clinical audit organisation (ICNARC) has facilitated this; collaborative work with ICNARC has ensured that high quality patient descriptor data is married to the outcome data at relatively modest cost as systems and skills were already in place. Other considerations are the length of projected follow up, the number of patients to be recruited and the number of sites involved. As a direct consequence we have tried to continually develop newer, cheaper and more efficient methods of data gathering and processing. Whilst efficiency is certainly one important element to our work, the engendering the good will of the staff involved at the recruiting sites is vital.

Our group has invested significant time and effort in developing a computerised system that can handle and process the study data. Data enters the system in either electronic, paper based or manually inputted form. The format that the data is submitted to the study office in is at the discretion of the recruiting site in an attempt to minimise additional administrative load at the recruiting centre. The computer optically reads paper-based data and then all inputted data is subjected to a series of validity checks. The system identifies inadequate or missing data for each patient and posts letters to relevant ICUs asking for its completion. The studies inclusion and exclusion criteria are checked and valid patient data is retained. Over the course of the study an individual patient's mortality is continuously monitored via the office of national statistics. Additional automated checks are performed with each patient's GP directly before each point of contact from the study to try and prevent relative offence by trying to contact patients that have unfortunately died. When the system has confirmed that a patient remains alive, it generates a specific questionnaire and covering letter and then awaits the patients' reply, with further reminder prompting if required. Data returned to the study office is once again optically read, validated and then entered into the database.

Crucially, the system has the ability to score and calculate the various instruments using the data returned by each individual patient. This not only provides real time analysis, but also importantly enables on the spot identification of those patients reporting significant signs of underlying psychological disease. The system also has an inbuilt live consort diagram which tracks the patients from one stage of the study to another adding the capability to detect in real time, patients not conforming to the study protocol. On the spot analysis and consort diagram creation are all considered powerful and necessary tools to facilitate the smooth running of a study, which at anyone one point in time can be tracking several thousand active patients.

Future Directions

The results of phase one of the ICON study will hopefully be published at the end of this year, with the aim to publish the results of phase two shortly afterwards.

The results of the i-Canuk pilot study of the economic impact of ICU treatment are also planned for publication and it is hoped that the pilot data can be used to refine the economics questionnaire and then apply it to a national UK or other European Union population. The addition of even longer follow-up periods, more complex case-mix data and more refined patient tracking, heralds an exciting new stage to HRQoL studies in ICU survivors. Rigorous, long-term follow-up observational data is essential to acquire the information necessary to plan and conduct future randomised controlled trials to evaluate emerging candidate interventions that aim to improve recovery after critical illness. ■

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Introduction

Non-Invasive Ventilation (NIV), the provision of ventilatory assistance using techniques that do not bypass the upper airway, is widely used in the management of selected patients with acute respiratory failure (ARF). The main theoretical advantage of NIV is avoiding the side effects and complications related to endotracheal intubation (Pingleton 1988).

NIV interfaces are devices that connect ventilator tubing to the face, allowing the delivery of pressurised gas into the airway. The choice of an appropriate interface is one of the critical issues affecting NIV success and requires scrupulous evaluation of the anatomical features of the patient, the etiology of ARF, and the ventilatory mode used to administer NIV. In a recent web-based survey (Crimi et al. 2010) of 272 intensive care units and respiratory wards throughout Europe, the oronasal mask was the most widely used interface for ARF, followed by nasal mask, full face mask and helmet, irrespective of clinical scenarios. By focusing the analysis on the Italian subsets of responders, the helmet was rated as the second most employed interface for the treatment of cardiogenic pulmonary oedema (Crimi et al. 2011).

The following sections will concentrate on the characteristics, advantages and disadvantages of the helmet, as well as the physiologic aspects of NIV delivered by the helmet.

Characteristics, Advantages of and Contraindications to the Helmet

Use of the helmet has been reported in the management of patients with both hypoxemic and hypercapnic ARF (Antonelli et al. 2004). The helmet is a clear plastic hood that contains the patient's head and is joined to a hard plastic ring supporting a soft rubber collar. Two pipe-connectors are placed at the two sides of the helmet for the expiratory and the inspiratory limbs of the circuit. The helmet is generally secured to the patient by armpit braces. All the helmets are latex-free and available in different sizes.

Compared with oronasal mask, the helmet has important advantages:

a) It is better tolerated and allows a satisfactory interaction of the patient with the environment;
b) Its fixation system provides a good seal without major compression at contact points, thus minimising skin lesions;
c) It can be applied to any patient regardless of the facial contour, edentulism or facial trauma;
d) It causes less interference with speech;
e) It allows cough;
f) A specific connector placed in the plastic ring of the helmet can be used to allow the passage of a straw, thus allowing the patient to drink or to be fed a liquid diet.

The helmet cannot be used in either claustrophobic or tetraplegic patients. Also, the need for tidal volume monitoring may be considered a relative contraindication to the use of a helmet. In fact, during helmet-delivered NIV, patients receive only part of the large volumes given by the ventilator after inspiratory trigger activation. The rest of the volume is compressed around the head, pressurising the helmet. It is not possible therefore to measure patient tidal volumes and flows by conventional bedside monitoring.

Ventilatory Modes

Helmet-delivered NIV is mostly applied as pressure support ventilation (PSV). Also Continuous Positive Airway Pressure (CPAP) may be administered non-invasively in various forms of ARF. CPAP delivers a constant pressure throughout spontaneous breathing in patients with an intact respiratory drive and adequate alveolar ventilation. CPAP can increase functional residual capacity and open underventilated alveoli, thus decreasing right to left intrapulmonary shunt and improving oxygenation and lung mechanics (Katz et al. 1985). In addition, CPAP may reduce the work of breathing and dyspnea in patients with chronic obstructive pulmonary disease (COPD) by counterbalancing the inspiratory threshold load imposed by intrinsic positive end-expiratory pressure (PEEP) (Petrof et al. 1990). Finally, by lowering left ventricular transmural pressure in patients with left congestive heart failure, CPAP may reduce left ventricular afterload with-

out compromising cardiac index (Naughton et al. 1995). CPAP can be delivered by various devices including low flow generators with an inspiratory reservoir, high flow Jet Venturi circuits (both of them with an expiratory mechanical or water valve), and bilevel or critical care ventilators. The helmet represents an elective interface to deliver CPAP, not needing the conventional reservoir and applicable also outside the intensive care unit to treat cardiogenic pulmonary oedema (Foti et al. 2009).

PSV is a pressure-triggered, pressure-targeted, flow-cycled mode of ventilation. PSV delivers a preset inspiratory pressure to assist spontaneous breathing, augmenting spontaneous breaths and offsetting the work imposed by the breathing apparatus.

In a physiologic study (L'Her et al. 2005) performed in patients with acute lung injury, non-invasive PSV combined with PEEP improved dyspnea and gas exchange, and lowered neuromuscular drive and inspiratory muscle effort. In such patients, CPAP used alone improved oxygenation but failed to unload the respiratory muscles.

Carbon Dioxide Rebreathing

Due to the large internal gas volume of the helmet, a possible problem related to the use of the helmet for NIV or CPAP might be the rebreathing of carbon dioxide (CO_2). Compared to the oronasal mask, the helmet behaves differently in respect to CO_2 exchange. It has been shown that the oronasal mask constitutes an additional mechanical deadspace, and its effect on CO_2 rebreathing is proportional to its internal volume (Criner et al. 1994). Because this volume is small compared with the patient's tidal volume, the amount of CO_2 that is rebreathed is also small. By contrast, CO_2 exchange during helmet ventilation follows the model of a semiclosed environment, such as a closed room provided with an air exchange system (Taccone et al. 2004). According to this model, the factors determining CO_2 concentration inside the helmet are the amount of CO_2 produced by the patient and the fresh gas flow that flushes the helmet. As a consequence, the volume of the helmet has no direct effect on the CO_2 concentration, but only on the rate at which a given CO_2 concentration is reached.

When helmet CPAP is used, CO_2 rebreathing also depends on the method adopted to deliver CPAP. Applying CPAP with a critical care ventilator may be associated with abnormal CO_2 accumulation inside the helmet. The reason for this effect is that ventilators provide CPAP with a gas flow that is equal to the patient's minute ventilation. Under these circumstances, if the system has no leaks, no additional fresh gas flow is delivered to remove CO_2 during expiration. On the contrary, when helmet CPAP is given with a continuous free flow system, CO_2 rebreathing can be minimised by a high fresh gas flow (Taccone et al. 2004). Using a different experimental setup, the inspired partial pressure of CO_2 seems to be independent of the level of CPAP and inversely correlated to the fresh gas flow delivered. High gas flows of 45-60 L/min render the CO_2 rebreathing clinically irrelevant during helmet CPAP (Patroniti et al. 2003).

Compared to CPAP, helmet-delivered NIV in PSV mode can provide a more efficient CO_2 washout, probably because of the phasic administration of inspiratory flow during such a ventilatory mode. Of note, the analysis of CO_2 rebreathing during helmet-delivered PSV does not show significant reductions in inspired partial pressure of CO_2 by increasing the level of inspiratory assistance (Costa et al. 2005). In a sophisticated computational fluid dynamic model to evaluate the effective dead space between different devices, Fodil et al. (2011) showed that the dead space differed only modestly (110-370 mL) between total face mask and the helmet, confirming that effective dead space is not related to the internal gas volume included in the interface.

Asynchrony

Optimal synchrony between the patient's spontaneous breathing activity and the ventilator's set parameters is one of the key factors determining tolerance to NIV. Patient-ventilator asynchrony may be determined by a number of events including ineffective triggering, double-triggering, auto-triggering, premature cycling, and delayed cycling. The lack of an optimal patient-ventilator interaction can lead to an increase in the work of breathing and patient discomfort (Kondili et al. 2003).

Physiologic studies on healthy subjects (Chiumello et al. 2003; Racca et al. 2005) found helmet less efficient in unloading the respiratory muscles when compared with standard oronasal mask. An explanation hypothesised for this finding is that the pressure delivered by the ventilator during helmet ventilation is partially spent to pressurise the large inner volume of the helmet, with a lower level of assistance in the initial phase of the breathing effort. In addition, because of the mechanical characteristics of the helmet, expiratory trigger efficiency might be adversely affected when non-invasive PSV is given through the helmet, thus worsening patient-ventilator asynchrony.

Moerer et al. (2006) found that, although delay times are prolonged during helmet ventilation, pressure time product is initially smaller (indicating less work of breathing) compared to NIV with the oronasal mask, due to the large volume inside the helmet that the patient can access. In this study, the authors also suggested that the highest PEEP and PS levels clinically indicated and tolerated by the patient

> *"Accumulating evidence supports the use of the helmet to improve gas exchange and avoid endotracheal intubation in selected hypoxemic ARF patients, in particular those with acute cardiogenic pulmonary oedema or postsurgical respiratory failure".*

should be applied when NIV with a helmet is used, in order to increase the elastance of the system, enhancing the trigger sensitivity. However, when adding PS level, a close and careful clinical monitoring is needed because it is likely to further shorten the delay times and promote the occurrence of wasted inspiratory efforts, thus reducing the tolerability of the technique (Moerer et al. 2006).

Vargas et al. (2009) suggested that increasing both PEEP and PS level and using the highest pressurisation rate may be advisable when providing NIV via a helmet. In their study, the helmet with the same settings as the oronasal mask was associated with less inspiratory-muscle unloading and with worse patient-ventilator asynchrony. In contrast, specific settings provided similar unloading, as well as improved the inspiratory trigger delay, and induced no further discomfort. Navalesi et al. (2007) showed that despite the inspiratory and expiratory delays the duration of diaphragmatic assistance in PSV is comparable between the mask and the helmet. Anyway, an optimal ventilator setting is crucial to NIV outcome irrespective of the interface used.

Clinical Applications

Use of the helmet to deliver either CPAP or NIV has been described in the management of ARF of various etiologies (Antonelli et al. 2004; Foti et al. 2009; Squadrone et al. 2005). However, caution should be applied in using the helmet to treat decompensated COPD patients because the efficiency of the helmet in eliminating CO_2 is reduced as compared to the conventional oronasal mask. Accumulating evidence supports the use of the helmet to improve gas exchange and avoid endotracheal intubation in selected hypoxemic ARF patients, in particular those with acute cardiogenic pulmonary oedema (Foti et al. 2009) or postsurgical respiratory failure (Squadrone et al. 2005). Furthermore, the helmet should be considered in all patients undergoing long term NIV/CPAP treatments to limit the complications of the technique and improve patients' tolerance. In this context, alternating different interfaces may be the best strategy. ■

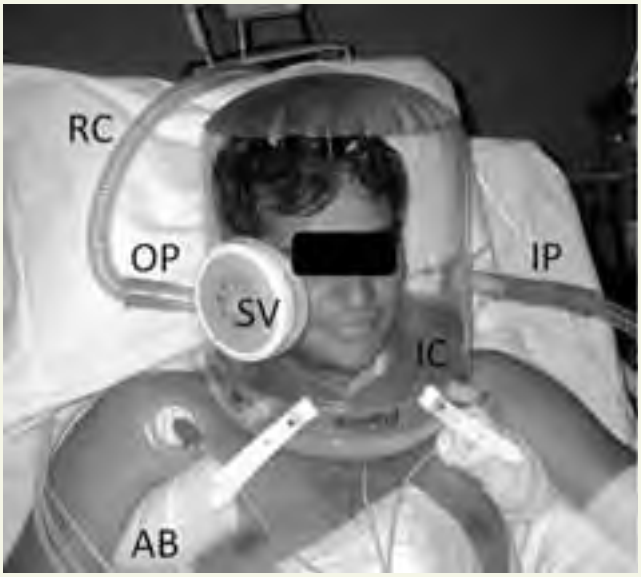

Figure 1
Non-invasive ventilation delivered through a helmet

Legend
AB armpit braces;
IC inflated cushion;
IP inlet port;
OP outlet port;
RC respiratory circuit;
SV security valve.

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Nihon Kohden is redefining Quality of Care with new, non-invasive technologies like PWTT and esCCO™ by introducing volumetric information to all care levels. Since the invention of pulse oximetry by Nihon Kohden researcher Takuo Aoyagi in 1974[1], the pulse wave has become the most commonly used vital signal in clinical practice. Estimated Continuous Cardiac Output (esCCO) is a new technology to determine the cardiac output using Pulse Wave Transit Time (PWTT) which is obtained by the pulse oximetry and ECG-signals from each cycle of the ECG and peripheral pulse wave. esCCO provides real-time, continuous and non-invasive cardiac output measurement.

Principle of esCCO

The possibility to derive the cardiac output from pulse pressure information by,

$CO = SV \times HR = (K \times PP) \times HR$

(CO: cardiac output; SV: stroke volume; K: constant value; PP: pulse pressure; HR: heart rate) established in various continuous cardiac output systems using the pulse-contour-analysis, built the starting point for the novel technology esCCO™. A better correlation between SV and PWTT was observed compared to that between SV and PP[2], and the formula providing cardiac output values was determined to be expressed by PWTT-Information as follows;

$CO = SV \times HR = K \times (\alpha \times PWTT + \beta) \times HR = esCCO$

[α,β: experimental constants]

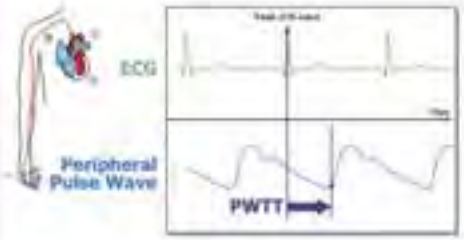

Figure 1: Pulse Wave Transit Time derived from ECG and pulse oximetry signal

Performance of esCCO

Ishihara et al. reported that esCCO™ derived from PWTT-Information is highly correlated with cardiac output determined by thermodilution technique[3]. In 2009, a multi center study at seven facilities verified the effectiveness of esCCO as a practical application (Fig 2).

Reliable Measurement with Non-Invasive Calibration

The ambition in research and development though, was the provision of volumetric information, especially for mid and low care levels, to improve patient care and enhance patient safety. With that, the challenge was to avoid any kind of invasive or minimal-invasive calibration.

By only entering patient information such as age, gender, height and weight, and an initial NIBP measurement, esCCO™ determines a reference value for calibration and is ready for start the measurement. Additionally, a cardiac output value obtained by other CO devices such as by pulmonary artery catheter can be used for calibration. Both calibration modes reliably track changes in cardiac output and provide advanced monitoring of a patient's hemodynamic status.

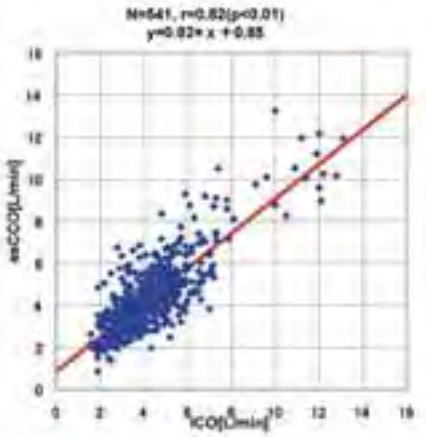

Figure 2: Comparison between esCCO[4] and cardiac output by cold bolus thermodilution (tCO) [5]

A Clearer View of Patients' Hemodynamics with New Hemodynamics Graph

For quality patient care, comprehensive management of different hemodynamic parameters is crucial. Hemodynamics Graph is a new monitoring tool which offers graphical view of overall hemodynamic information. The key components of Hemodynamics Graph are the Trend Graph combined with 2 Target Graphs. Target Graphs (Fig 3) work with various parameters including continuous and less-invasive ones as well as intermittent invasive ones (e.g. cardiac output by bolus thermodilution). The horizontal axis (X axis) shows a parameter related to preload such as PPV and CVP; in contrast, the vertical axis (Y axis) shows a parameter related to cardiac function such as cardiac index. A line connecting plots of different brightness level on the Target Graphs shows trace of hemodynamic change over time, which allow clinicians to easily grasp the direction and tendency of patients' hemodynamic change and assess the condition based on the Forrester classification[5] (Fig 4). Target Graph offers more intuitive approach of diagnostic and therapeutic decision making by visual display of not only measurement data but also Target area, which indicates a target area of treatments.

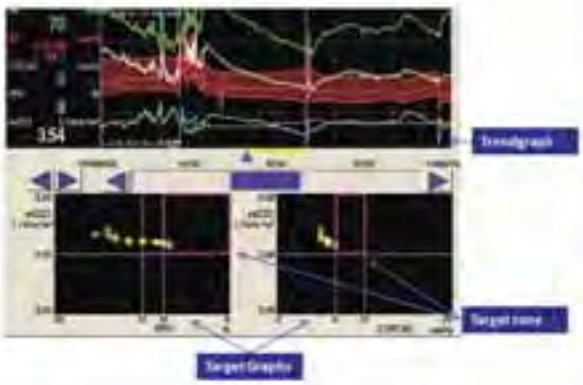

Figure 3: Hemodynamic response to the administration of 200 mL of glycerin

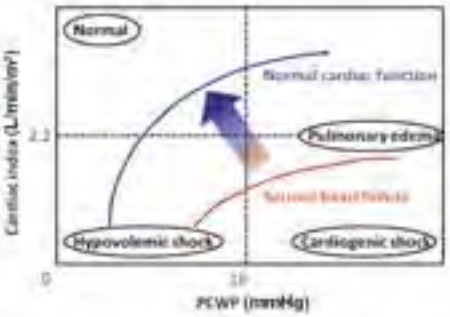

Figure 4: Forrester Classification

The Figure 3 screenshot shows a time course of hemodynamic response through the administration of 200 mL of glycerin. A yellow bar just below the Trend Graph, starting with an Event Mark recorded at the time of intervention, shows the time interval of the Target Graph below. The traces on both of the Target Graphs show that hemodynamics is falling within the Target area in response to the administration of glycerin.

This Hemodynamics Graph may open up new ways to manage patients' hemodynamics more efficiently and effectively.

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A CHANGE MANAGEMENT PERSPECTIVE ON A NOVEL META-ANALYSIS: EARLY ENTERAL NUTRITION IN TRAUMA PATIENTS

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The first step in any practice change initiative involves an 'appraisal' of the research evidence to understand its inherent potential to change practice. As an example, a novel meta-analysis of early enteral nutrition in trauma is assessed.

Introduction

Up to 30% of all hospitalised patients receive care that is inconsistent with current best research evidence (Buchan 2004). Evidence-practice gaps can be reduced in a complex environment such as the intensive care unit (ICU) however the degree of practice change that can be achieved depends upon a number of factors (Doig et al. 2008; Martin et al. 2004). Traditionally, practice change initiatives begin by identifying barriers to change (Simpson and Doig 2007) and understanding inter- and intra-professional communication patterns (Sinuff et al. 2007). Once these factors are understood an efficient practice change strategy composed of effective focussed interventions (Ex. Active reminders, audit and feedback etc) is designed (Simpson and Doig 2007). In addition to the above considerations, there are certain inherent qualities of the research evidence itself that may affect practice change. We recommend the first step in any change management initiative should involve a detailed appraisal of the research evidence to determine its inherent practice change potential.

In their seminal review, Davis and Taylor-Vaisey (1997) summarised the five main qualities of research evidence that make a new treatment more likely to be translated into practice:

1) The new treatment can be demonstrated to be superior to the old treatment in terms of patient benefit;
2) The new treatment supports existing beliefs;
3) The clinician can observe others trying the new treatment;
4) The new treatment is relatively simple and;
5) Parts (or all) of the new treatment can be tried by the clinician with ease.

The purpose of this paper is to focus on the intrinsic qualities of research evidence that may facilitate practice change, using early EN in trauma patients as a representative topic.

Early EN in Trauma: Evidence from a Novel Meta-Analysis

Trauma surgeons were amongst the first to conduct Randomised Controlled Trials (RCTs) investigating the benefits of early EN (Moore and Jones 1986). Although no single clinical trial has been large enough to demonstrate a significant reduction to mortality, a recently published meta-analysis of RCTs concludes that early EN significantly reduces mortality from trauma if EN is started within 24 h of injury or ICU admission (Doig et al. 2011).

The results of this novel meta-analysis are based on an extensive electronic literature search that identified 13 RCTs that evaluated timing of EN initiation after trauma. Four of these 13 clinical trials did not report patient outcomes, four evaluated the role of immune-enhanced EN products and one RCT did not start EN within 24 h of injury or ICU admission in the early group. The remaining four clinical trials evaluated the role of standard EN commenced within 24 h of injury or ICU admission and were included in the meta-analysis.

The four included RCTs enrolled a total of 189 patients. With a mortality rate of 10% in the standard care arm, a conservative meta-analytic technique appropriate for 'sparse outcomes' was used. Peto's assumption free method reported mortality was significantly lower in patients receiving early EN (Figure 1; Odds Ratio = 0.26, p=0.04, I2=0). Furthermore, one included trial showed a strong reduction in pneumonia (p=0.050) and a second included trial demonstrated a strong reduction in severity of multiple organ dysfunction syndrome (MODS) (p=0.057) in patients receiving early EN. A complete critical appraisal of this meta-analysis can be found online (http://www.evidencebased.net/framesetJC.html, Accessed 17 June 2011).

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Inherent Qualities of Research Evidence Relevant to Practice Change

1) The new treatment can be demonstrated to be superior to the old treatment in terms of patient benefit.
New treatments with clear patient benefits are more likely to be implemented into practice. Although clinicians are aware that costs must be constrained, they are more reluctant to implement a new treatment if its main advantage is lower costs.

Numerous independent sources corroborate the patient benefits attributable to early EN. For example, the authors of the Eastern Association for the Surgery of Trauma (EAST) guideline on Nutritional Support in Trauma Patients conclude that early EN leads to a reduction in MODS, intra-abdominal abscesses and pneumonia in trauma patients (Jacobs et al. 2004). Additionally, meta-analyses of clinical trials conducted in similar patient groups demonstrate early EN reduces mortality in major gastrointestinal surgery patients (Lewis et al. 2008) and in critically ill patients (Doig et al. 2009). Furthermore, an extensive review of all the evidence failed to demonstrate any proven harms arising from the provision of early EN (Heighes et al. 2009).

The new meta-analysis by Doig et al. (2011) does not need to stand alone. Significant benefits to trauma patients attributable to early EN have been documented by other reviewers and similar benefits have been reported in other patient groups. Practice change is easier to achieve when evidence of patient benefit is robust and clear.

2) The new treatment supports existing beliefs.
If the results of new research are congruent with existing beliefs, uptake into practice may occur more easily.

The finding of a mortality reduction in trauma patients attributable to early EN is consistent with current physiological theories. Since 1975 it has been recognised that MODS is an important complication of severe overwhelming trauma (Baue 1975). In 1986 it was hypothesised that the 'gut' was the motor driving the onset of MODS due to changes that occur in the gut wall leading to increased permeability and resultant translocation of bacteria from the gut into the patient's bloodstream.

Today, it is accepted that early EN reverses the gut wall changes that lead to increased permeability (Goldberg et al. 2008) resulting in down-regulation of systemic immune responses and oxidative stresses which drive the incidence and severity of MODS. Any reduction in MODS would be expected to translate directly into a reduction in mortality.

3) The clinician can observe others trying the new treatment.
The identification of an innovator or early adopter is a powerful way to leverage change amongst any group of clinicians. The innovator / early adopter passively influences change by allowing their peers to observe the real world consequences of implementing a new treatment. Enabling the innovator / early adopter to provide education in the context of formal or informal practice audits allows experiential knowledge gained by the innovator to be shared with their peer group thus increasing the groups' confidence in their mastery of the new treatment and overcoming barriers to their own first use.

Because early feeding of critically ill patients has been promoted by high-profile quality improvement initiatives (Vincent 2005), innovators and early adopters should be easy to identify in any ICU that is targeted for improvement. If no clinicians in the target ICU are currently feeding trauma patients within 24 h of injury or ICU admission, it is likely that innovators / early adopters are feeding other ICU patient groups early. Clinicians who feed general critically

> *"Significant benefits to trauma patients attributable to early EN have been documented by other reviewers and similar benefits have been reported in other patient groups."*

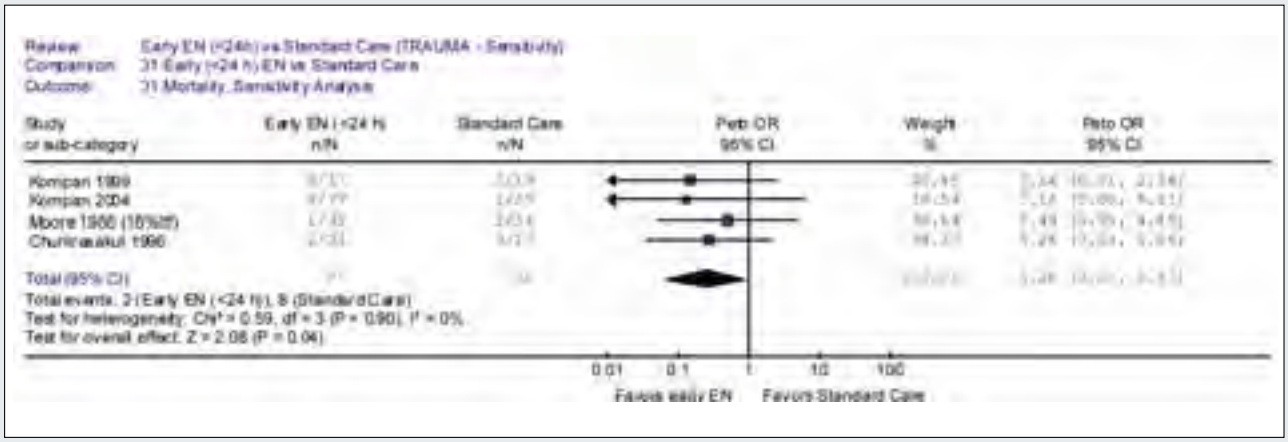

Figure 1. Early EN (←24h) vs Standard Care.

ill patients early are most likely to become innovators in the trauma population.

4) The new treatment is relatively simple. To make the new treatment as easy as possible to implement, a Treatment Recommendation Statement (TRS) should be prepared to summarise the new treatment for potential adopters. The TRS must be succinct but provide all key elements that a clinician requires to implement the new treatment appropriately.

The following TRS for early EN in trauma is based on the RCTs included in the meta-analysis by Doig et al. (2011): Begin standard EN within 24 h of injury or ICU admission, as soon as shock is stabilised. Stable shock can be defined as Shock Index ≤ 1 (heart rate ÷ systolic blood pressure = Shock Index) or systolic blood pressure > 90 mmHg or mean blood pressure > 70 mmHg for at least one hour. Set starting rates and nutritional goals as per local ICU policy or standard practice. Gastric or post-pyloric feeding tubes may be used.

In the above example, a statement regarding shock was required since all trials included in the meta-analysis started early EN after shock was resolved. Because clinicians use slightly different end points to guide resuscitation, a working definition of 'stable shock' was based on criteria published in the included trials. With regards to EN starting rates and goals, because all included trials used different starting rates and goals, we chose not to stipulate specific starting rates and goals in our TRS. Preserving clinical judgement in areas where information conflicts may result in increased adherence to other key areas of the TRS (Doig et al. 2008).

The above example is over-simplified for illustrative purposes. An appropriate local process, which includes all key stakeholders, should be undertaken to generate the actual TRS used at each target site. Each target site's TRS may differ slightly however the consideration of local factors in the generation of a simple statement will enhance implementation.

5) Parts (or all) of the new treatment can be tried by the clinician with ease. The provision of early EN is a flexible intervention. The clinician can pick and choose the most appropriate patients for an initial trial and initial EN starting rates may be lower than the clinician usually uses. Once confidence and skills are established, more complex patients may be fed and starting rates may be increased.

Summary

Although clinicians are more likely to change practice when presented with the definitive results of a well conducted multi-centre clinical trial conducted in their own healthcare setting, a meta-analysis of smaller trials may also appropriately influence practice change (Doig et al. 2008; Perrier et al. 2011).

Inherent qualities of research evidence, such as clear patient benefits, compatibility with existing beliefs and values, "observability", complexity, and "trialability" all contribute towards a new treatment's uptake into practice (Davis and Taylor-Vaisey 1997). Using a novel meta-analysis demonstrating that early EN reduces mortality in trauma patients as an example, we show how appraisal from the perspective of these practice change qualities may lead to a better understanding of the potential for change. Understanding the potential for change is a necessary first step towards achieving any real change. ■

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IMPACT OF PHARMACOKINETICS OF ANTIBIOTICS IN ICU CLINICAL PRACTICE

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Introduction

The efficacy of a drug is mainly dependent on its ability to achieve an effective concentration in the target tissue. However the risk of toxicity limits the dose that can be administered.

Critically ill patients often have increased cardiac output, capillary leak, modification of proteins serum levels and binding properties. Additionally increased renal and hepatic clearance or, on the contrary, organ failure, are common and lead to significant pharmacokinetic (PK) changes (Roberts and Lipman 2006). Antibiotic dosing is especially challenging in these patients, due to increased volume of distribution (Vd) and changes in clearance (Cl). Besides antibiotics killing kinetics is dependent on drug class, and different patterns of exposure are necessary for antimicrobial success (Drusano 2004).

Unfortunately, therapeutic drug monitoring is only available for a small number of antibiotics. Nevertheless knowledge of PK may help to select appropriate dosage and schedule intervals that might contribute to therapeutic success.

Principles of Pharmacokinetics

Pharmacokinetic refers to the study of drug concentration during a timeframe and its distribution in different tissues of the body, namely its absorption, bioavailability, distribution, protein binding, and also its metabolism and excretion. Clinical PK is the application of these principles to design individualised dosage regimens, which optimise therapeutic response while minimising the chance of an adverse drug reaction.

Bioavailability is the drug proportion, which actually reaches systemic circulation (usually 100% for intravenous route). Distribution occurs when drug molecules leave the vascular system to different compartments, either tissues or organs. Their chemical conversion is called metabolism. Excretion is the irreversible elimination of a drug from the body.

Most drugs follow a linear PK (its concentration changes proportionally with dose). However, some, like phenytoin, presents non linear, Michaelis-Menten, PK (Bauer 2008).

Pharmacodynamics (PD) relates drug concentration to the pharmacological response. However, drug effect may not be proportional to drug concentration because the pharmacological drug effect depends on its ability to form a complex with a receptor. Once these are saturated, a maximum response will be obtained. Often adverse effects of drugs follow the same type of concentration response relationship.

Volume of Distribution

Serum concentration of a drug depends of the amount delivered, its bioavailability and the Vd. The Vd is a mathematical construct and refers to the size of a compartment necessary to account for the total amount of the drug, assuming that its concentration in the whole body is the same as the measured in plasma [Vd=(dose*bioavailability)/concentration]. Drugs that distribute mainly in the extracellular fluid have low Vd (0.2-0.3L/kg), whilst drugs that have rapid cellular uptake have high Vd (in excess of 0.6 L/Kg).

In general, Vd is above normal in critically ill patients. Volume resuscitation, blood products, vasopressors, positive pressure ventilation, surgical procedures, capillary leak and reduction in albumin serum concentration, all contribute to this increase in Vd. Therefore with the same dose, peak concentrations are usually lower. This is especially important after the first dose of a drug, when the drug concentration is only dependent on the Vd. If a lower dose is given (namely to adjust for renal failure), a lower concentration will be obtained, which may contribute to therapeutic failure. Nevertheless maintenance doses should be reduced (or intervals enlarged) to avoid accumulation and toxicity.

When drug Cl remains unchanged, a rise in Vd, although associated with a lower concentration, proportionally increases the t1/2, since

t1/2=Vd/(Cl*0.693). This might be a useful effect for antibiotics that depend on time to act (like β-lactams), but a major disadvantage for concentration-dependent agents (like aminoglycosides).

Drug doses may need to be adjusted depending on its tissue penetration and the intended effect. Many antimicrobials do not penetrate well in cerebrospinal fluid and higher doses may be necessary to treat meningitis. By contrast, at excretory sites, such as the urine, drugs may concentrate and use of lower doses may be appropriate (Estes 1998).

Excretion

In the hyperdynamic septic patients, there is commonly an increased renal and hepatic blood flow and often an increased drug Cl (Weinbren 1999; Roberts and Lipman 2006; Baptista et al. 2009). To achieve adequate therapeutic levels some antibiotics may need higher than usual doses (Pea and Viale 2009). Oliguria inversely leads to drug accumulation and toxicity.

Prescription guidance is well established in chronic renal failure. However in acute renal failure there is often a narrow therapeutic range between ensuring effectiveness and preventing toxicity. Under modern renal replacement therapy, there is a significant risk of underdosing, when doses previously defined for stable chronic renal failure patients are used (Fish et al. 2005).

The effect of liver dysfunction on drug concentrations is less well defined, with numerous interactions, which make it only possible to prescribe on an individual basis. Of note, patients with liver disease often have decreased renal Cl, although with a normal serum creatinine. Thus dose reduction may be necessary even for drugs essentially cleared by the kidneys (Morgan and McLean 1995).

Antibiotic Pharmacokinetics

One of the major characteristics of these drugs, which determine their timeframe activity, is whether its killing rate depends on drug concentration or on the duration of exposure (Craig 2003). The second major characteristic is the post antibiotic effect (PAE), the persistent effects that last after antimicrobial concentration fall under the minimal inhibitory concentration (MIC). Antibiotics that inhibits nucleic acid or protein synthesis tend to have larger PAE (Mehrotra et al. 2004).

However antibiotic PK changes in critically ill patients, especially the increase of both the Vd and the Cl, makes its concentration difficult to predict (Figure 1), especially those of hydrophilic antimicrobials (e.g. β-lactams, aminoglycosides, glycopeptides) that distribute mainly in the extracellular space. Moreover, antibiotic efficacy is not easily assessed, as its effects are usually unnoticeable before 48 h of therapy. Therefore failure of the antimicrobial treatment may occur because of the inability of the antimicrobial to achieve adequate concentrations at the infection site.

When choosing a drug dose to attain the desired target, it is important to recognise the range of MICs that might be found clinically. The higher the MIC, the lower the probabilities of attaining its PK/PD target. Consequently high antibiotic doses, according to their PD profile, should be used to ensure bacterial killing, especially in critically ill patients. However these high antibiotics doses also increase the risk of toxicity.

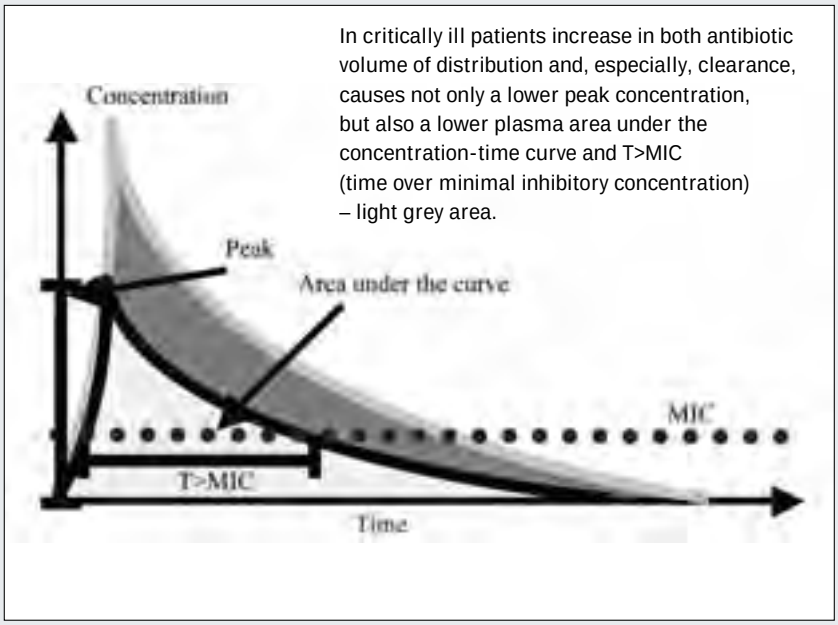

Table 1. Antibiotic concentration during pharmacokinetic changes

Time Dependent Antibiotics

β-lactams attach and block penicillin–binding proteins, responsible for the stability of bacterial cell wall peptidoglycan. Bacteria death occurs when a considerable portion of these proteins are occupied. As the drug concentration increases, its effect quickly maximises and higher drug concentrations do not result in significantly greater bacterial killing. On the opposite, if antibiotic concentration falls, bacteria proliferate almost immediately, especially Gram-negative organisms. Therefore β-lactams are time-dependent antibiotics and its T>MIC is the major PK/PD parameter that correlates with efficacy (Craig and Ebert 1992).

The administration of this class of antibiotics with short time intervals or the use of continuous infusion maximises time of bacteria exposure to adequate drug concentration and may improve patient outcome. Despite clinical trials failed to show a clinical benefit from this strategy, there are theoretical arguments, results from animal studies and case reports supporting the efficacy and safety of continuous or prolonged infusions (Mouton and Vinks 1996). Moreover, prolonged infusion (4 h) of piperacillin tazobactam in patients with severe Pseudomonas aeruginosa infections was associated with a significant reduction in mortality (12.2% vs. 31.6% with conventional administration schedule; p=0.04) (Lodise et al. 2007). The same was noted with continuous infusion of ceftriaxone in critically ill patients (Odds Ratio for survival with continuous infusion - 22.8; p=0.008) (Roberts et al. 2007).

In severe infections, where the risk of underdosing is higher, continuous infusion of β-lactams has proven to be safe, with at least a comparable therapeutic efficacy and may even improve patient survival and help prevent the emergence of resistant strains.

Concentration Dependent Antibiotics

Some antibiotics, like aminoglycosides, show rapid concentration dependent killing and have a large PAE. This PAE increases with the ratio between peak concentration and MIC (Peak:MIC) (Moore et al. 1987).

Aminoglycosides are extracellular drugs, poorly bound to proteins and therefore, also susceptible to PK changes occurring in the critically ill patients. Therefore, even with high antibiotic doses, the increased Vd of critically ill patients may preclude the achievement of a high Peak:MIC ratio. In a study from our group (Goncalves-Pereira et al. 2010), despite a gentamicin median loading dose of 7.4 mg/kg, only 31.3% of patients achieved a gentamicin peak concentration above 20mg/L. This was due to a marked increase in Vd, 0.41 L/kg, without any correlation with SOFA score, Charlson score, age, or renal failure. The same increased Vd (0.41L/kg) was found following the first dose of amikacin (Taccone et al. 2010) and, consequently, 30% of the patients did not achieve their therapeutic target, 64mg/L.

The fear of oto and nephrotoxicity may prevent the use of these high aminoglycoside doses. However in a study of 373 patients treated with gentamicin, despite a decrease of 0.5% per day in creatinine clearance, these changes did impact neither patient outcome nor the incidence of clinical significant renal failure (Buchholtz et al. 2009).

Exposure Dependent Antibiotics

Fluoroquinolones have a high Vd and present both renal and hepatic Cl. Therefore their PK parameters are not significantly affected by critical illness. Also renal failure is not associated with significant drug accumulation, unless the patient has also concomitant liver pathology. These antibiotics are concentration dependent and a Peak:MIC ratio of 10 predicts bacterial eradication (Roberts and Lipman 2006). However, concerns about neurotoxicity of such high doses, may preclude its use. Therefore, the AUC:MIC is the parameter usually associated with outcome.

However, a ciprofloxacin dose of 400 mg bid only achieved an effective AUC:MIC for bacteria with a MIC less than 0.25 mcg/ml (van Zanten et al. 2008). Using the same antibiotic in critically ill patients, Lipman et al. showed that 400 mg tid was both safe and provided an AUC:MIC bactericidal ratio against most organisms (Lipman et al. 1998). These higher AUC:MIC may also reduce the risk of selecting resistant mutants, a major concern with fluoroquinolones (Andes et al. 2004).

Vancomycin is also an AUC:MIC ratio dependent antibiotic. Nevertheless in one study of MRSA hospital-acquired pneumonia no correlation was found between the outcome and vancomycin AUC (survivors 351; non survivors 354mg*h/L; p=0.941) (Jeffres et al. 2006). However the authors failed to provide the MICs. Therefore, it was not pos-

sible to rule out a correlation between survival and AUC:MIC.

Can we use Pharmacokinetics to Guide Antibiotic Therapy?

Antibiotic PK variability is largely unpredictable at the individual level. Therapeutic monitoring is therefore desirable and had been shown to facilitate the achievement of adequate serum levels (according with PK/PD targets), to decrease toxicity and even to contribute to prevent resistance development (Burgess 1999). Unfortunately dosing of antibiotics is only largely available for aminoglycosides and vancomycin.

Pharmacokinetic studies on β-lactams had also shown potential benefit from real time application of therapeutic drug monitoring. Serum ceftazidime concentration was measured in a cohort of 92 patients receiving continuous infusion (Aubert et al. 2010). The mean serum ceftazidime concentration was 46.9 mg/L but with a very large range of concentrations (7.4–162.3 mg/L). Dosage modification was necessary in a large number of patients, both with low concentration (36.9%) or potentially toxic levels (27.2%).

Pharmacodynamic modelling was also used to empirically treat VAP in critically ill patients in ICUs with a high prevalence of antibiotic resistant Pseudomonas aeruginosa (Nicasio et al. 2010). A 3-hour infusion regimen of either cefepime or meropenem at high dose (2 g every 8 hours) was used followed by both antibiotic and dose descalation, when a low MIC was identified. With a before and after design, an infection-related relative mortality reduction of 69% was found (8.5% vs 21.6%; p=0.029) and fewer superinfections were observed.

Conclusion

Changes of the antibiotics PK in critically ill patients, puts such patients at risk for either underdosing or prolonged drug exposure. Therefore, conventional dosing should be replaced by strategies aiming to tailor concentration to the individual patient. Microbiological and pharmacokinetic data may help to improve clinical outcome and to prevent resistance. ■

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LONG-TERM OUTCOME AFTER ABDOMINAL COMPARTMENT SYNDROME

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Introduction

The past two decades have witnessed a tremendous evolution in our understanding and management of patients with Intra-Abdominal Hypertension (IAH) or Abdominal Compartment Syndrome (ACS). Improved diagnosis and institution of both medical and surgical management strategies have significantly increased survival, improved long-term functional outcome, and decreased hospital resource utilisation in these complex patients. Central to this evolving strategy are the use of early serial Intra-Abdominal Pressure (IAP) measurements to detect the presence of IAH, application of comprehensive medical management strategies to reduce elevated IAP and restore end-organ perfusion, and timely surgical decompression of the abdomen for refractory ACS and organ failure.

In the early days of IAH/ACS management, abdominal decompression was commonly employed as a "last ditch effort" in patients with well-established ACS resulting in a uniformly poor outcome and the perception that surgical intervention was futile. As our understanding of IAH/ACS pathophysiology improved and IAP monitoring was adopted by increasing numbers of critical care units, IAH/ACS was diagnosed at earlier stages where appropriate intervention was found to be lifesaving. Damage control laparotomy and use of the "open abdomen" in patients at risk resulted in notable decreases in the incidence of ACS and increases in both patient survival and abdominal closure rates. Much of the improvement in patient outcome has been achieved over the past several years since publication of the World Society of the Abdominal Compartment Syndrome (WSACS) consensus statements and algorithms, which for the first time, provided evidence-based definitions and recommendations for the comprehensive management of patients with elevated IAP (Malbrain 2006; Cheatham 2007). Through earlier diagnosis, (before IAH progresses to ACS), and with multi-modality IAP management to avoid end-organ failure, many centres have witnessed a marked decline in the incidence of ACS. In fact, the success of these strategies has changed the previous goal of avoiding ACS and its mortality into reducing the incidence of IAH and its detrimental effects on end-organ function.

The Fifth World Congress on the Abdominal Compartment Syndrome, recently held August 10-13th, 2011 in Lake Buena Vista, Florida, identified both the success of the IAH/ACS diagnosis and management algorithms proposed by the WSACS (http://www.wsacs.org), but also the need for increased IAP monitoring and greater worldwide implementation of these proven guidelines if IAH/ACS mortality is to decrease further. This review discusses both the current and recently presented literature regarding long-term outcome following IAH/ACS and presents a proven strategy for achieving similar results in any hospital setting.

Survival

Ennis et al. retrospectively evaluated a comprehensive resuscitation protocol in 118 burn patients that incorporated many principles from the WSACS definitions and recommendations (Ennis 2008). These included serial IAP monitoring, judicious fluid resuscitation with early use of colloids, goal-directed hemodynamic monitoring, maintenance of adequate abdominal perfusion, and decompressive laparotomy for refractory ACS. Compared to historical controls, the protocol decreased the incidence of ACS from 16% to 5% ($p=0.06$) and mortality from 31% to 18% ($p=0.1$). When ACS and mortality were combined as an endpoint, survival improved from 64% to 82% ($p=0.03$).

Vidal et al. prospectively studied 83 patients in a combined medical-surgical ICU (Vidal 2008). Thirty-one percent of patients had IAH upon ICU admission and another 33% developed IAH subsequently. Patients whose IAP remained below 12 mmHg had a mortality of 27% while those whose IAP exceeded that level had a mortality of 53% ($p=0.02$). IAP was identified to be an independent predictor of survival ($p=0.003$). Of note, 12% of patients developed ACS with an associated mortality of 80% as surgical decompression was not performed in patients who failed non-operative IAH/ACS management.

Cheatham and Safcsak prospectively compared the outcome of patients requiring open abdominal decompression (OAD) both before and after institution of a comprehensive resuscitation protocol incorporating the WSACS guidelines (Cheatham 2010). During the study, patient survival improved significantly from 50% to 72% ($p=0.015$). Clinically significant decreases in intensive care unit (ICU), hospital, and mechanical ventilator days were identified. Mean days to

abdominal closure decreased from 20 ± 14 to 10 ± 10 days ($p<0.01$) and the rate of same-admission primary fascial closure increased from 59% to 81%. In multiple regression analysis, ACS was independently associated with a five-fold increase in mortality (Odd's Ratio [OR] 0.18; $p<0.0001$) and early abdominal decompression a three-fold increase in survival (OR 3.2; $p<0.0001$). The use of a multi-modality surgical and medical management algorithm was an independent predictor of survival ($p=0.018$).

Mentula et al. retrospectively studied the benefit of OAD in 26 patients with severe acute pancreatitis resulting in ACS (Mentula 2010). While overall hospital mortality was 46%, patients who received OAD within four days of disease onset had a mortality of 18% and those decompressed after five or more days had a mortality of 100% ($p<0.0001$).

Acosta et al. described their four-year prospective experience in 151 vascular, general surgery, or trauma patients who required OAD and were managed using vacuum-assisted / mesh-mediated fascial closure (Acosta 2010). They achieved definitive abdominal closure in 89% of patients with an in-hospital mortality rate of 29.7%. Median IAP decreased significantly from 20 to 11 mmHg following OAD ($p=0.001$). Age (OR 1.21; $p=0.027$) and failure to achieve fascial closure (OR 44.5; $p=0.043$) were independent predictors of in-hospital mortality.

In an abstract presented at the Fifth World Congress, Seternes et al. reported their retrospective experience with IAH/ACS in patients with ruptured abdominal aortic aneurysms (Seternes 2011). Survival in 2002-2005 (prior to institution of the WSACS guidelines) was 59%, while survival in 2006-2010 (incorporating a comprehensive IAH/ACS resuscitation strategy) was 73% ($p=0.08$) suggesting that systematic IAP measurement and prevention and treatment of ACS is associated with improved survival.

Cheatham et al. evaluated the impact of age upon survival of 405 IAH/ACS patients treated with a comprehensive IAH/ACS management protocol (Cheatham 2011). Survival by decade of life exceeded 50% through the eighth decade, but decreased to 19% for the ninth decade (greater than 80 years of age). Survival similarly varied significantly by service (trauma 72%, surgical 56%, burns 55%, medical 33%) ($p<0.0001$). Successful definitive abdominal closure rates (range 75-100%) were equivalent among all age groups ($p=0.78$). Survival following OAD thus varies by decade of life and mechanism of injury / illness, but reasonable survival rates can be expected for patients less than 80 years of age.

Arhinful et al. retrospectively studied 67 patients greater than 80 years of age who required damage control laparotomy and OAD (Arhinful 2011). They reported an in-hospital mortality of 37% and definitive abdominal closure rate of 52%, both notable figures considering the age of the population studied. Further, they documented a 66% survival at two years post-OAD. In multivariate regression analysis, congestive heart failure and postoperative acute renal failure were identified as independent predictors of mortality.

Long-Term Functional Outcome

While survival and abdominal closure rates are clinically important, the impact of IAH/ACS management upon long-term physical and mental health, quality of life, and subsequent employment potential are of greater importance to the patient. Cheatham et al. retrospectively surveyed 30 OAD patients in various stages of abdominal closure in the pre-WSACS guidelines era (Cheatham 2004). Patients awaiting abdominal hernia repair demonstrated significant decreases in physical health, physical capability, and energy level, and significant increases in bodily pain, social dysfunction, and emotional problems. Patients without an incisional hernia demonstrated significant decreases only in their ability to perform a full range of physical activities without limitation. Mental health was not decreased in either group. Successful abdominal reconstruction thus restored a patients' physical health to normal. Of note, none of these patients were permanently disabled or unable to resume gainful employment as a result of their abdominal decompression. These authors subsequently prospectively surveyed 44 OAD patients in the first 24 months following management using the WSACS guidelines (Cheatham 2008). At six months post-decompression, physical and social functioning were significantly decreased among patients with a chronic incisional hernia, but not among patients who had achieved definitive abdominal closure prior to hospital discharge. By 18 months, chronic incisional hernia patients had returned to normal physical and mental health perception. Quality adjusted life years did not differ between groups. Both demonstrated similar ability to resume employment (41% vs. 55%; $p=0.49$). Thus, OAD does not have a negative impact on long-term physical or mental health perception, quality of life, or the ability to resume employment.

Zarzaur et al. surveyed a select group of 41 OAD patients who required delayed abdominal wall reconstruction a median of six years post-injury (Zarzaur 2011). In contrast to the previous study, they identified a significant decrease in physical health, but found that 67% of patients had resumed employment following abdominal reconstruction. They also noted that 65% of their patients screened positive for depression and 23% for post-traumatic stress disorder (PTSD). They concluded that OAD patients can achieve near-normal quality of life, but that depression or PTSD may occur as a result of their critical illness.

- Implement an IAH/ACS screening programme in all critical care areas
- Measure IAP in all emergent intensive care unit admissions and patients with worsening critical illness
- Perform serial IAP / APP measurements in all patients at risk throughout their critical illness
- Institute a comprehensive IAH/ACS management protocol to maintain IAP ↓ 20 mmHg
- Perform timely abdominal decompression in all patients who fail non-operative management
- Achieve definitive abdominal closure in all patients prior to discharge

Legend: *IAP – intra-abdominal pressure; IAH – intra-abdominal hypertension; ACS – abdominal compartment syndrome; APP – abdominal perfusion pressure*

Table 1. Key hospital performance indicators for the prevention and management of IAH/ACS

Resource Utilisation

In the early days of IAH/ACS management, Split-Thickness Skin Grafting (STSG) of the exposed viscera, commonly after insertion of absorbable mesh and subsequent granulation, was considered standard therapy. This management strategy is labour-intensive, costly, and associated with significant morbidity and potential mortality (Cheatham 2010; Cheatham 2011; Zarzaur 2011). Given the improved survival and long-term physical and mental health outcome associated with abdominal closure, same admission definitive fascial closure should be the goal following OAD. A recent study of 324 patients OAD patients identified significant differences in resource utilisation depending upon the abdominal closure method utilised (Cheatham 2011). Following risk-adjustment for severity of illness, primary fascial closure was associated with significantly reduced ICU and hospital length of stay, mechanical ventilator days, and hospital charges when compared to progressive abdominal closure, biologic mesh, STSG, or skin-only closure techniques ($p<0.05$). Days to abdominal closure ($p<0.0001$) and development of an enteroatmospheric fistula (EAF) ($p=0.002$) were identified as independent predictors of increased hospital charges following OAD. Further, patients who underwent early OAD had significantly lower hospital charges compared to those requiring emergent decompression for ACS ($p=0.002$). Thus, early abdominal closure, when physiologically appropriate, should be the goal following OAD. STSG is costly, resource-intensive, and should be avoided except in those patients where attempts at fascial closure have failed or are contraindicated as in the presence of an EAF. To subject all patients with an open abdomen to STSG incurs unnecessary risk, cost, morbidity, and potential mortality.

The Future

Over the past decade, the clinical importance of elevated IAP has been widely recognised, but comprehensive medical and surgical management strategies and resuscitation algorithms have been implemented by relatively few centres worldwide. Many ICUs still do not measure IAP in patients at risk and many physicians do not provide timely therapy to patients who develop IAH/ACS. The reasons for withholding these potentially lifesaving interventions are multi-factorial, but typically stem from a misunderstanding of these disease processes or unfamiliarity with the current medical literature. As a result, patient survival and long-term outcome is not what it could be. As the developing evidence outlined above illustrates, earlier recognition and appropriate intervention in patients at risk for IAH/ACS significantly increases patient survival, improves long-term functional outcome, and reduces hospital resource utilisation. A plethora of ongoing clinical trials will further confirm these findings.

These improvements in patient outcome can be recognised in any hospital setting with minimal capital expense. The process for improving the diagnosis and management of patients with IAH/ACS is well-outlined in the patient care algorithms proposed by the WSACS (http://www.wsacs.org). Increased awareness of the etiology, prevalence, and patient groups at risk for IAH/ACS is the first step. This requires serial IAP monitoring in appropriate patients to both detect the presence of IAH and guide ongoing resuscitative therapy. A series of key hospital performance indicators to achieve such improvements in patient outcome is listed in Table 1. If physicians and hospitals were to adopt these indicators and implement a multi-disciplinary IAH/ACS management protocol, they would be well on the way to providing patients with the best care possible and making a significant difference in their future. ■

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AVOIDING DISASTERS: A TOOL FOR ESTIMATING THE NEEDS OF HEALTHCARE RESOURCES AT SPORTING AND OTHER PUBLIC EVENTS

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Sporting events have the potential to turn into major incidents. Thus, as part of the planning for such events, there should be an estimation of the needs for medical teams and healthcare resources based on a simple calculating method.

Different kinds of events are held in various locations around the world and under different geographical and weather conditions. Some are organised regularly and arranged by major event organisers with extensive experience, while others might be staged for the first time and by organisers with no experience of arranging events at all (Eisenhauer 2005). Besides economical benefits for the community and organisers, staging events also implies responsibilities to the visitors, some from cities or countries far away. Regardless of the type of event, what they have in common is a planned gathering of people with similar interests.

In planning, it is important to note that the larger the group of people, the greater the likelihood of someone suffering from an acute illness or minor injury that may require healthcare services and treatment. For each organiser, the primary goal, besides a well-organised event, should be the safety of participants, staff and spectators. Experiences from different events indicate that about 1-2% of the spectators will need some form of medical assistance and of those 10% will need further treatment, while about 1% require transportation to a hospital (Arborn 2007). Providing the best medical coverage may differ due to the type and location of this specific event. A crowd in itself poses an increased risk that an untoward event may develop into a major incident. Race cars crashing into spectator stands or crowd panic during soccer games are examples taken from different types of sports events when multiple fatalities and casualties have occurred (Eisenhauer 2005).

Thus, every event needs careful consideration regarding the need for medical coverage, both regarding "everyday illnesses", as well as the risk of a major incident occurring. The safety during an (major) event is closely correlated to crowd behaviour and control, aspects usually dealt with by police and stadium owners. Consequently, it is evident that planning for an event should be performed in close cooperation between the different stakeholders (organisers, police, healthcare system, fire service, etc.). Early communication between the different representatives is necessary to clarify the "risk profile" of the event and how to best deal with issues of concern. The medical needs during an event will be influenced by the anticipated number of spectators, geographical and climate conditions, as well as opposing fractions of spectators, etc. (Arbon 2005).

An easy to use tool for risk assessment and management would simplify this process. Various tools have been proposed, however, articles describing the use of such tools for different kinds of events are very limited. Arbon et al. developed an estimation method to assess the medical needs for sporting events (2004), while Milsten et al. described how eleven different factors with high impact on healthcare outcome should be taken into consideration (2002). However, since these methods are theoretical others have tried to use simplified models (Hartman et al. 2009).

Since we considered these systems too complex to use, we decided to use the British "Event Safety Guide", often referred to as "The Purple Guide" (2005) as a template (See Table 1. below). This guide is a comprehensive guideline intended to be used for concerts and other types of music events. A simple scoring system to calculate the medical resources for a given event is part of the guide. We used a revised version of this scoring system a couple of years ago to issue recommendations regarding health and safety during music events in Sweden. Therefore, we decided to find out if this template could be used also to estimate healthcare resources at sporting and other public events.

In a pilot study, we asked six experienced EMS planners to use the revised template for all upcoming events in their districts and evaluate its simplicity, usefulness, accuracy and also express their opinion if they would use such a template themselves. Since sporting events was not an available option in this template, they were asked to choose another activity (concert, festival, etc.), which was similar with regards to risk. The response was positive and in 97% of cases their assessment of resources needed with this tool corresponded to that made previous years of the same event.

As a next step, we trained 27 experienced event planners to use the template. These participants were not involved in the pilot study described above. They were tested to confirm

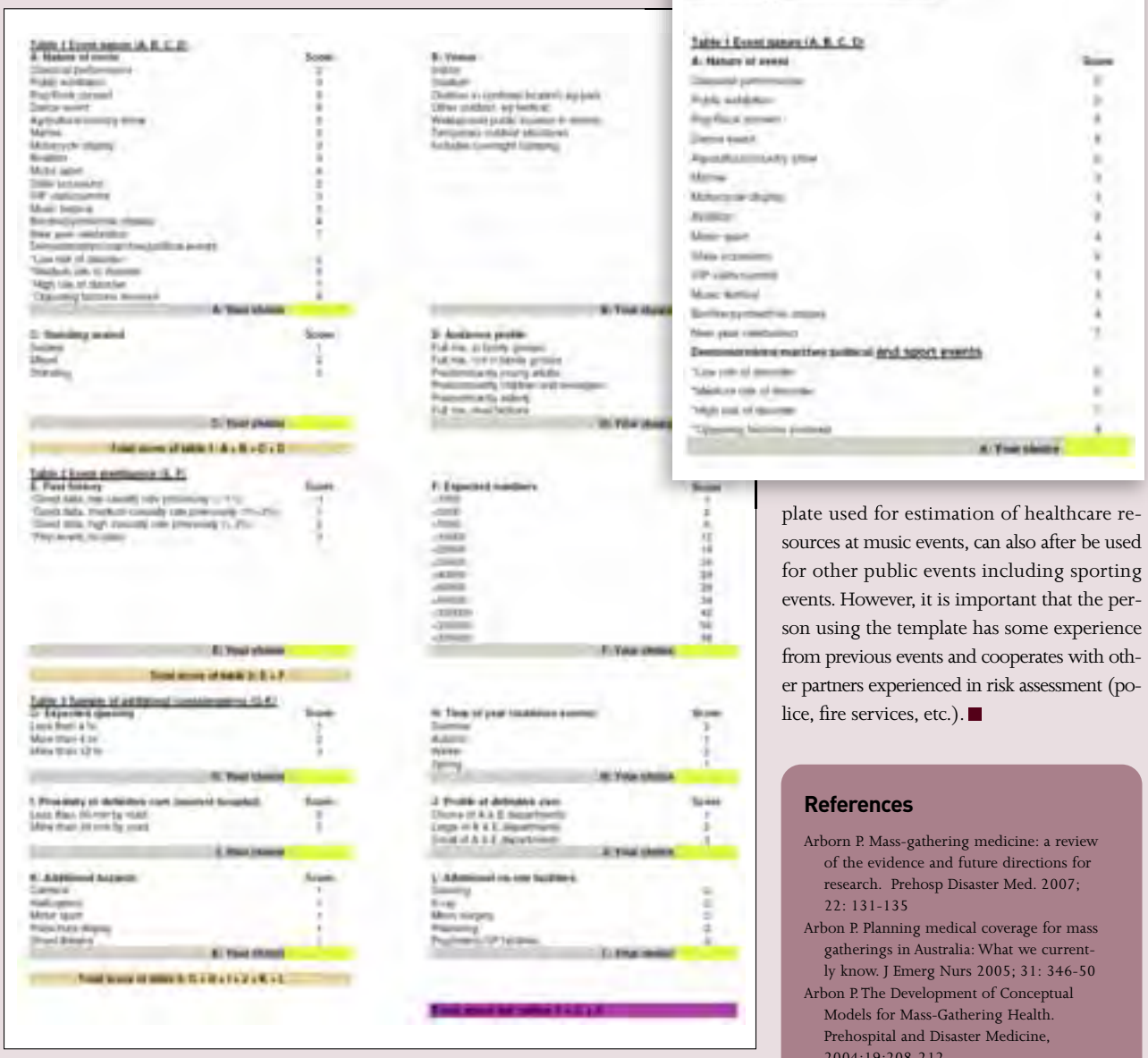

Table 1. Modified healthcare resource estimation guidelines (top right corner: one of the sections enhanced).

their knowledge and ability to use the template by letting them assess the need for medical resources in three non-sporting events (national day celebrations, festivals and concerts). In the original template, there are 12 different choices of events. One of these needs a risk assessment for the risk of disturbances at the events (marches/political; events/demonstration). The template was then adjusted to be used for sport events. By adding sport events into this category, the planner was forced to classify the event as low risk of interference, medium risk of disorder, high risk of disturbances and the risk for encounter between the rival groups. The scenarios used for sport events were trot, soccer /football and ice hockey. The results were in good accordance with resources usually deployed at such events. It was evident that the template might primarily be easier to apply to arena-based sport events as compared to events covering a larger geographical area (Rally racing, etc.). However, the most important factor for estimation of healthcare resources, irrespective of the type of events, is still the expected number of visitors (Khorram-Manesh et al. 2010).

In conclusion, the adjusted Swedish template used for estimation of healthcare resources at music events, can also after be used for other public events including sporting events. However, it is important that the person using the template has some experience from previous events and cooperates with other partners experienced in risk assessment (police, fire services, etc.). ■

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WE NEED TO CONNECT

AN INTERVIEW WITH **PROFESSOR JEAN-DANIEL CHICHE**

For this "After ICU" edition of ICU Management, Managing Editor Sherry Scharff sat down with Jean-Daniel Chiche to discuss a range of engaging topics including the allure of intensive care medicine as a specialty, the need to push away from the "hero" culture and the importance of being human.

PROFILE

Intensivist in the 24-bed MICU at Cochin Hospital in Paris, France

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Research Director at the Cochin Institute, and

President elect - European Society of Intensive Care Medicine (ESICM)

What brought you to the field of intensive care?

When I first entered the ICU as a medical student, I was immediately struck by the emotional intensity. It is one of the few specialisations in medicine where you can go from complete quiet to a crisis situation within minutes and you will be called upon to use not only your hands, but also your brain— and your heart all at the same time. I often say that this is internal medicine of life-threatening disease, and this is the concept that I love about intensive care… Who doesn't want to be a specialist of life-threatening diseases? It basically challenges you to become knowledgeable about every discipline in medicine and then to be pragmatic enough to intervene quickly. There are so many unique and amazing attributes to working in the field of intensive care; it is not only that you play an instrumental role in life and death daily, but also that you do so as a team. There is powerful feeling of continuum from the head nurse to the nurse to the doctor to the scientist… A clear bedside to bench and back push towards a common goal of saving patients. I can't imagine doing anything else with my life.

What has propelled you to take on a leadership role?

In my 24-bed, mostly medical unit, we work as a cohesive team to care for the more than 1,600 patients admitted per year. But I realised early on that even if you work 24 hours a day in your unit, every day of your life, there is a limit to how much of an impact you can have on your patient's lives or the lives of the other members of your team. You may treat all 1,600 patients to the best of your ability, but you will not affect the system and the only way to truly improve outcomes is by changing the system. In this way, we really need to move away from the culture of the hero to the culture of the system. An excellent example of an industry where this culture is in place is air travel. When you decide to travel, you choose the location you need to get to, and the time you need to be there. You choose the airline based on the best combination of these elements (and cost). However, you would never consider basing your decision on which pilot is flying which flight, because you trust that the pilot from the 4 pm flight will be as good as the one from the 6 pm flight and they all have the proper credentials and training.

In intensive care, the ambulance goes right or left, and you are lucky or you are unlucky based on where you go and when you arrive. This is wrong. In intensive care, quality of care should be uniform from hospital to hospital and the level of care should not differ whether you arrive on Saturday at two in the morning or Monday at 11 am. If the disease is the same, than the response, treatment and outcome should be consistent, independent of all of these factors. If you feel strongly about the need for systematic change and the evolution of the field into a more structurally uniform state, you really need to take on a leadership role.

> *"Intensive care is a lot like Formula One. It's quick. It's dangerous. There is a lot of high tech equipment and high emotion—and it is expensive."*

What practical advice can be given to those people who want to incite constructive change in their units?

As a leader, you need to reflect on the organisation of your department. It might not

be that there is one perfect organisation that works everywhere; but in every department you to need consider the same factors:

- Case-mix;
- Pattern of ICU admission;
- Performance levels, and
- Observed mortality rates (are they lower than the predicted mortality in specific groups and across all patients?)

Finally, you need to make a candid assessment of the department, highlighting any areas where you can improve quality of care. It is striking to see for example, that volume matters. Patients who are ventilated in a high volume unit have much better outcomes than those who are suffering the same disease, with the same level of severity and are ventilated in smaller unit, with only 150-200 ventilated patients a year. I think that these observations will have some organisational consequences that may result in regionalisation of care in certain countries. Perhaps it will mean closing some small ICUs and instead putting the resources into bigger, more organised ICUs where you can also incorporate in-house teaching programmes and implement a staffing structure where there is at least one senior intensivist available at the bedside around the clock, daily.

This desire to change the predominant culture of intensive care has also been the drive for me to become more involved with ESICM. The scientific society is a wonderful instrument to provide better science, better education and training as well as to improve patient and public outreach for intensive care medicine.

What do you think are the predominant challenges in critical care for the next decade?

Sepsis today remains extremely frequent and although mortality has slightly gone down thanks to work that was initiated following the surviving sepsis campaign, for instance, we see know that sepsis still carries a high burden and remains a challenge in critically ill patients.

It is also important to start realising that the patients we treat successfully and discharge from our ICUs don't all go back to a normal life within a couple of weeks or months and long-term outcomes from intensive care medicine are going to become extremely important. This emphasis on long-term outcomes will certainly influence the way we treat ICU patients today. We already see a trend with regards to the use of less sedation, early mobilisation of these patients and now that we are studying occurrence of neuro-psychotic dysfunctions, cognitive defects, anxiety and depression, there will not only be an impact on how we treat our patients, but also on how we design our ICUs.

How would you describe your profession?

Intensive care is a lot like Formula One. It's quick. It's dangerous. There is a lot of high tech equipment and high emotion—and it is expensive. The main difference I see however is that Formula One is known to everyone and to our detriment intensive care is not. This leaves us with a huge vacuum of information—one that we must fill. We must connect citizens with intensive care medicine; before they or their families are in a life-threatening situation. It is the only way to confirm they understand the importance of the work that is done there and thereby ensure that we receive the resources that are needed to continue to improve short and long-term outcomes.

Is the LIFE Campaign part of this initiative to connect the public?

Last year we launched the LIFE Campaign at the European Society of Intensive Care Medicine with exactly this mission. This is not a short-term project, and we plan to carry on in the coming years, building on our successes and broadening our efforts. The 2011 edition of LIFE begins with increasing awareness on "What is intensive care? Why is it needed? And how can we make it better?"

Can you explain the motivation behind the displaying of letters at the 2010 congress?

Part of connecting the public with intensive care came through an invitation to patients and their families to submit letters describing their experiences during and following their ICU stay. For most of these patients we are transient in their lives; if they survive, they usually return to their primary physician or specialist (i.e. cardiologist; oncologist; etc.) and we don't have an opportunity to reconnect with them, to speak with them and or check their progress after they leave the doors of the ICU. What the letters did is to provide these patients and families with an opportunity to speak up and share their feelings about the time spent within the confines of the ICU and afterwards. For intensive care professionals, these letters opened their eyes to the realities, both good and bad, of patients and families experiences and moreover, emphasised the fact that many of these patients go on to lead enriched lives.

"In intensive care, quality of care should be uniform from hospital to hospital and the level of care should not differ whether you arrive on Saturday at two in the morning or Monday at 11 am."

You may recall the concert pianist Fred Hersch who performed in Barcelona last year: He spent two and a half months in ICU in a coma, ventilated, tracheostomised, undergoing haemodialysis and paralysed. He could not move his arms; much less envision playing the piano. Now, if you hear him play you cannot dispute that he has recovered. When he discusses it, he attributes intensive care with giving him a second chance at life. In fact, he has also gone on to produce a stirring and poignant musical based on his experiences during his time his time in the ICU. » Continues on p.43

OVERVIEW OF IRISH HEALTHCARE SYSTEM

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Ireland is one of a small number of countries where the delivery of Health and Social care services comes under the auspices of one government department. The range of services delivered ranges from neurosurgery at one end of the spectrum to child and family welfare services on the other end. Services are usually categorised by acute care, primary care, continuing care and community care services - such as disabilities, mental health, social inclusion and children and family welfare services. The delivery system is mixed with a range of public, voluntary and private providers in the different care settings.

Statistics:

Total population	4,515,000
Gross national income per capita (PPP international $)	35,710
Life expectancy at birth m/f (years)	77/82
Probability of dying under five (per 1 000 live births)	4
Probability of dying between 15 and 60 years m/f (per 1 000 population)	97/57
Total expenditure on health per capita (Intl $, 2009)	4,005
Total expenditure on health as % of GDP (2009)	9.7

Figures are for 2009 unless indicated.
Source:
Global Health Observatory

Health of the Nation

Over the past decade, Ireland has experienced unprecedented gains in health status and this has been paralleled by major investment in the health services. For many years Irish life expectancy lagged behind the EU average. An improvement over the last decade mean that overall life expectancy in Ireland stands at over 79 years, and is now almost one year greater than the average for the EU.

It is difficult to measure what proportion of this improvement may be attributable to better health services, but it is at least indicative that much of the gain has been in mortality from conditions particularly amenable to treatment and care such as heart and circulatory system disease. For example there has been a reduction of 38 percent in circulatory system disease between 1997 and 2005. In addition, over the same period, the cancer mortality rate has fallen by 13 percent and it now close to the EU average. In terms of breast cancer, the five-year relative survival rate is about 80 percent for the period 1999-2004 – the highest rate of improvement in the OECD. Infant mortality is also down by 35 percent in the last ten years.

Health Policy in Ireland

Health Policy is a matter for government, specifically the Minister for Health and Children. The role of the ministry, called the Department of Health and Children, is to advise on the strategic development of the health and social care system including policy and legislation and to evaluate performance of the health and social care system.

Delivery of services is the responsibility of a separate government agency, called the Health Service Executive (HSE). Government allocates funding to run the Health and Social Care system each year and agrees a service plan with the Health Service Executive that sets out the quantum and nature of services to be provided.

Funding our Healthcare System

Compared with other OECD countries, Ireland's health spending per capita ranks in the top half but when expressed as a percentage of GDP (7.6% in 2007) ranks at the lower end of the OECD spectrum. In 2009 15.5 billion euro was allocated to fund the public health and social care system in Ireland, including payments to family doctors and community pharmacists.

A review group, established by the minister for Health and Children, is due to report in 2010 on how to improve the funding model and the method of allocating resources, including how a population based funding model might lead to greater equity in allocation of funding to different parts of the country.

How Services Are Delivered

The Health Service Executive (HSE) has recently re-organised into four regional operating units with the intention of moving responsibility for service delivery closer to the populations they serve. Each region provides services to a population of around one million

people and services are delivered through a combination of public, voluntary and private providers. Within each region there are a number of hospital networks providing acute care and local health offices that provide a broad range of primary, community and continuing care services.

Acute care is provided through hospitals or hospital networks. These are principally state owned and run with the exception of the capital city, Dublin, where most of the hospitals are non-statutory. Continuing care is provided through networks of community hospitals, long stay facilities and private nursing homes. Significant emphasis is now being put on development of primary care teams that brings Family Doctors and Community Health Professionals, such as Public Health Nurses, into multi-disciplinary teams serving populations of between six and ten thousand people. In addition more specialist services in areas such as Child and Family Welfare, Disability and Mental Health services are delivered primarily through HSE providers or contracted to voluntary agencies.

Healthcare Reform in Ireland

Government made a major change in the organisation and management of services in 2005 that saw the establishment of a single agency with responsibility for delivery of all health and social care services, called the HSE. This replaced the ten former regional health boards. In addition a national body, called the Health and Information Quality Authority (HIQA) was set up to drive quality, safety, accountability and to ensure the best use of resources in our health and social care services, whether delivered by public, voluntary or private bodies.

Several very serious patient/client safety incidents resulted in the establishment of a commission on patient safety that has resulted in a number of recommendations for change. This coupled with the need for progress on several existing strategies and a continued focus on ensuring a more integrated service for patients/clients has led to the:

- Establishment of a Directorate of Quality and Clinical Care to bring renewed focus to define and implement models of care and to ensure our services are delivered to the highest possible standards;
- Creation of hospital reconfiguration programmes for groups of hospitals to ensure care is being delivered in the most appropriate settings that is resulting in significant changes for many hospitals;
- Planned rollout of over 500 primary care teams across the country by 2011;
- Implementation plan for change in Mental Health and other community services;
- Commencement of a series of integrating programmes that will focus on defining the patient pathways for priority areas such as diabetes and stroke; and
- Re-organisation of the HSE national directorates to bring our acute hospitals and Primary, Community and Continuing care divisions together under one umbrella.

Outlook in Current Economic Downturn

Ireland is no different to most other countries in the challenges it faces in the current economic downturn. The challenge will be to deliver accessible, high quality and equitable health services to those who need them, when and where they need them within available resources. This will bring pressures to bear on both health services and on the health of the population.

The demographic ageing of the population is a fact of life and will accelerate over the coming years. By 2025, there will be nearly double the number of people over the age of 65 as there are now. Lifestyle risks remain to the fore as major areas of concern with the potential to undo much of the health improvement achieved in recent years.

We have seen significant changes in how services are organised and managed in recent years, following thirty years of a relatively stable health and social care service delivery system in Ireland. This has been driven by the need for a safer and more effective system for patients and clients and we are continually trying to improve our system through a series of changes in the areas of funding, performance measurement, organisation and also in how services are accessed and delivered to our patients and clients. ■

» Continues from p.41

I think that for all healthcare professionals that work as a team in the ICU, the greatest reward is to see these patients come back, dressed and well and have them say "thank you for what you have done".

Do you feel that LIFE and similar campaigns are making a real impact on strengthening the connection between the public and intensive care staff?

We had a very interesting experience last year, which for me really emphasised the impact. At the congress in Barcelona, I asked some intensivists and nurses to read the letters from their patients aloud, in their own languages, for our video crew. When they began to read, most were unable to look at the camera, and became overwhelmed with emotion. At that moment, there was a clear realisation of the importance of what they do and they become more human beings than doctors.

I think sometimes we need this reminder, as nurses and doctors that we are in fact, first and foremost, human beings.

I often say to my students in class, that in our country, in France, if you want to become a flight attendant for Air France, for example, and serve diet cola in the air, you must first undergo a series of interviews where they will assess your motivation to do the job and ultimately, judge whether you are worthy and able to do it. This is not the case for medical students. On the contrary, if you have good grades and a good ranking, you become a doctor. So I think that one of the side effects of the LIFE Campaign is to remind the doctors and nurses that work in intensive care that the essential element of what we do is LIFE—not only supporting survival, but improving quality. ■

INTENSIVE CARE MEDICINE IN IRELAND: UNITY AND PROGRESS BEYOND BORDERS

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Still in the throes of economic turmoil and famous for political disputes, there are many reasons why one might wonder how Ireland's Intensive care Medicine (ICM) system could be accurately summarised while the country remains in such a state of flux. The division of this island into Northern Ireland and the Republic has never prevented close cooperation within the ICM community, however. Although two healthcare systems operate on the island of Ireland, the unity of purpose of the critical care community, north and south, has generated a collaborative entity in terms of continuing education, research, training systems and examinations. This is a considerable accomplishment for the Irish ICM community, as divisions between these jurisdictions were strong during the last 50 years as the specialty developed.

We now have a well-organised ICM training programme, with a fellowship examination, which has cross-border support and recognition. A collaborative clinical trials group has been established and has published some fundamental descriptive data. However a lack of integrated planning and inadequate bed capacity mean that there is still much to address in ICM here. The fact that the Republic of Ireland is currently undergoing such a dramatic economic reversal will make this particularly challenging.

History

The first critical care units evolved in Belfast and Dublin around 1960 and several factors accelerated the development of intensive care in the following years, particularly the coming of 'open heart' surgery (with cardiopulmonary bypass) in 1961. Critical care nursing (and associated training programmes) began in 1971. As in many European and other countries, the medical staffing of intensive care units was initially by anaesthetists, with mechanical ventilation as the keystone of the service. More formal medical training in Critical Care started with the foundation of the Intensive Care Society of Ireland (ICSI) in 1987 and was consolidated with the origin of the Irish Board of Intensive Care Medicine in 1994. There are now 12 major ICUs (recognised for training) in Ireland. Building upon these foundations enabled us in 2005 to introduce an all-island collaborative Irish Critical Care Trials Group (ICCTG). The latter has drawn on international assistance, including from the ANZICS critical care trials group, to make important first steps in publishing some fundamental descriptive data for Ireland.

Specialisation

Irish doctors, being from a small country with a tradition of emigration, have tended to travel widely during training, often returning here with pioneering expertise. Thus the first specialists here to identify themselves primarily as intensivists had experience within the Australian and US medical systems. Specialty bodies were founded largely by these internationally trained intensivists, who had seen first hand elsewhere how the role was developing away from theatre anaesthesia. The evolution towards specialty status was further advanced when the first diploma of the Irish Board of Intensive Care Medicine (DIBICM) was awarded in 1997 and the first joint exam was given with the European Diploma in Intensive Care (EDIC) in 2001. This has become integrated within the Irish training bodies for anaesthesia, medicine and surgery in conjunction with the ICSI and recently has gained Fellowship status under the auspices of the Joint Faculty of Intensive Care Medicine (JFICM, Ireland) in 2008.

The nascent Joint Faculty of Intensive Care Medicine oversees certain interests of our developing specialty. This body aims to develop training programmes for medical specialists with an interest in ICM, determining the nature and duration of their specialist training, and the examination entry criteria. The JFICMI will accredit suitable ICU's for such specialist training. It also supports ICM specialists with their continuing professional development and coordinates courses for this purpose. They are also keen to advance the role of the intensivist to full specialist status, and commenced the formal application process with the Irish Medical Council in this regard. The

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precise division of duties between the JFICMI and the ICSI is still becoming clear, however.

Intensive Care Society of Ireland (ICSI): Today

The ICSI presently has a membership of over 200. Membership has declined somewhat as the separation between anaesthetist and intensivist has been established. It has taken on a multiplicity of roles, primarily involving promotion of the development of ICM in Ireland. These promotional roles are achieved by organising meetings and scientific symposia; encouraging research including by the awarding of grants; and interacting with healthcare authorities at various levels. The society also arranges courses in collaboration with the training committee of the ESICM and with the BASIC programme, providing introductory training in the discipline of ICM. Since 2003 the ICSI also coordinates more advanced courses preparing candidates for the specialist diploma exam. There are two regular conferences per year, a large international meeting and another regional meeting. The latter is often held in collaboration with a special interest group, such as the Microbiology Society (ISCM), the Northern Ireland Intensive Care Group, the College of Anaesthetists, or the University College London Anaesthesia / Intensive Care group. The UCL joint meeting is in Dingle, and takes place every alternate year, including in October 2011. There are also refresher courses (two per year), which rely primarily on Irish experts, but the larger conferences incorporate international speakers. The calibre of these speakers has been outstanding, a pattern we hope to sustain. Further joint meeting have been held with the ESICM, the ICS (UK), the Scottish Society (SICS) and the Irish association of

The ICSI also takes a role in patient advocacy. Its status as a non-governmental, charitable organisation makes this possible. This at times involves meeting with individuals or patient groups who are unable to interpret their experiences of critical illness, or who are unhappy with the services they have received. We can help them articulate their views or to lobby for change. More commonly, it involves raising awareness of the lack of bed capacity that creates unnecessary pressure in many hospitals in Ireland.

Irish Critical Care Trials Group

The advent of the Irish Critical Care Trials group is one of the most promising aspects of the ICSI. While much high quality ICU research has been conducted at laboratory level in Ireland in recent years, the clear pattern of modern times is that meaningful clinical ICU studies must be collaborative and multi-centred. The first such paper from Ireland was a descriptive study of demand for ICU resources (Charles et al. Ir Med J 2002). The predictable finding that we had 99% bed occupancy has been helpful in the patient advocacy role previously discussed. Also the identification of units for that study that could collate and report data efficiently has been useful for further work, some of which has been reported. These include studies on acute respiratory distress syndrome and catheter-related sepsis. These are by convention published under the authorship of the Irish Critical Care Trials group. Hypothesis-testing randomised trials are in their early stages by now, including a large study on the effect of statins in sepsis.

Progress

High quality audit has been lacking in Irish hospital medicine, perhaps because of the large number of small hospitals the country has. The economies of scale of modern medicine are leading to integration of care, and a major reconfiguration of services is planned. This should enhance the ability to record and measure throughput and outcomes. In the field of ICM we are likely to collaborate with the ICNARC data collection systems of the United Kingdom. It would seem difficult to envisage a much better audit system and the advantages for collaboration between the two islands are obvious. Some units in the Republic and in Northern Ireland are already working with ICNARC and the ICSI aim ultimately for full participation.

Transport of the critically Ill within Ireland has traditionally been inadequate. A Mobile Intensive Care Ambulance service (MICAS), set up in 1996 by the Irish Dept of Health in conjunction with the ICSI, aimed to deal with this issue by providing a designated ambulance, which was staffed by experienced ICM trained staff for the retrieval of critically ill. This has generally been a success and the road network has also improved greatly. Northern Ireland also initiated a retrieval service (NICCATS), which is more complete in its functionality, working on a 24/7 basis. While tertiary services are specialised in the bigger cities, until recently the road network made rapid transit very difficult when dealing with unstable patients. The recent establishment of an extracorporeal life support (ECLS) centre in Dublin has further expanded the role of this transport service. It has recently been possible for the most unstable patients to be commenced on extracorporeal membrane oxygenation at outlying centres and rapidly moved several hundred kilometres by road to the ECLS centre by the retrieval team.

Future Challenges

The pattern of the Irish economy in recent years must raise concern about the future of critical care as an expensive form of medical practice. Since around 2006 the country has been severely affected by the consequences of an economic collapse. By that time the government in the republic had commissioned a major analysis and report on Intensive Care services with a view to planning future bed requirements, from Prospectus, a consultancy group. Its aim was to provide a template to plan for 2020 so that services by then could match population needs. However the government and its authorities have not yet even published the report, which cannot bode well for its implementation. It found that we have roughly half of the bed capacity required at present. As the costs of ICM in Ireland are over €2200 per bed day, a doubling of critical care bed capacity is difficult to envisage in the present economic conditions.

The great dilemma we are likely to face in the coming years will be how to optimally provide for a growing, and ageing, population with resources that are already inadequate. Economic hardship will also probably worsen the health of many of the population. Because of this, paradoxically, recessionary times tend to increase medical inflation. Nonetheless, the enthusiasm of the ICM community here is enormous. Ireland remains an outward-looking and optimistic country, and those of us involved in caring for the sickest patients hope to maintain the momentum established in recent decades by our colleagues. ■

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2–5 22th ESPNIC Medical & Nursing Congress
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www.espnic.de

3-4 Asian Intensive Care: Collaboration Conference
Hong Kong, China
www.aic.cuhk.edu.hk

11–12 ESA Autumn Meeting
Krakow, Poland
www.euroanesthesia.org

11-12 Sepsis Congress 2011
New Delhi, India
www.apcc-india.com

15-17 Emergency Medicine in the Developing World
Cape Town, South Africa
www.2011.emssa.org.za

16-19 7th World Congress of the World Society for Paediatric Infectious Diseases (WSPID 2011)
Krakow, Poland
www.euroanesthesia.org

22-24 Doppler-Echocardiography in Intensive Care 2011
Erasme University Hospital, Brussels, Belgium
www.ulb.be

DECEMBER 2011

6-8 17th Postgraduate Refresher Course
Erasme University Hospital, Brussels, Belgium
www.ulb.be

11-14 Update on Neuromonitoring
Rome, Italy
www.intensive.org

12-14 The Intensive Care Society (UK) Annual State of the Art Meeting 2011
London, UK
www.ics.ac.uk

JANUARY 2012

18-19 IT @ Networking 2012
Brussels, Belgium
http://itandnetworking.org/

19-20 40th International Congress of Intensive Care Medicine SRLF-Paris
Paris, France
www.srlf.org

FEBRUARY 2012

3-4 17th International Symposium on Infections in the Critically Ill Patients
Barcelona, Spain
http://infections-online.es/

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