EUROPEAN MORTALITY & **L**ENGTH **O**F **S**TAY IN **I**CU **E**VALUATION STUDY (ELOISE)

Background:

Over the past 50 years, intensive care turned out to be a central component in almost every hospital. As a consequence of the increased demand for more and more sophisticated life-support therapies, cost of intensive care has become a significant financial burden. In the US for instance, the cost of intensive care is almost 1% of the Gross National Product (Parrillo)

Despite the high cost of Intensive Care Unit (ICU), a significant number of patients surviving intensive care do not survive hospital stay because they die subsequently after the transfer to ward. Mortality rates after discharge from ICU have been reported to range from 6.1 to 27% (Rowan KM 1993, Latour J 1990, Goldhill DR1998, Munn J 1995). More recently, Azoulay et al found a hospital mortality of 10.8% for ICU survivors who stayed in intensive care more than 48h (Azoulay 2003), and of 10.4% for ICU survivors with infection (Azoulay 2005). The Italian Group for the Evaluation of Interventions in Intensive Care Medicine (GiViTI) reported an increase in the cumulative mortality of the patients admitted to 180 Italian ICUs in 2005 from 16.5% at ICU discharge, to 21.5% at hospital discharge (Boffelli 2005). In the hospital outcome cohort of the SAPS 3 study involving 16,784 patients the mortality increased from 17.7% in the ICU to 23.5% at hospital discharge (Metnitz 2005).

In 2000, Goldfrad and Rowan found that premature discharge from ICU was more likely to occur at night and was associated with higher death rates. Suggested factors that might account for a worse outcome for night discharges were poorer quantity and quality of care available at night both during transfer and at the destination. The implication of this study for the health system was that many hospitals did not have enough ICU beds. To facilitate earlier ICU discharges of ICU patients who are thought to need more care than those which can be provided on wards, InterMediate Care Units (IMCU) with level of nursing staff (and costs) lower than ICU were proposed more than a decade ago (Bone 1993, Zimmerman 1995, Ryan 1997, and Weissman 2000).

However the literature on the efficacy and the cost-effectiveness of IMCU available at present shows variable results.

Studies that support the implementation of ICMUs:

In 1997, Ryan et al () found that high-dependency patients occupied 23% of ICU bed days and suggested that IMCU would improve ICU bed availability and allow for costs of care reduction. In a subsequent editorial, Vincent and Burchardi (1999) emphasized the need to

rationalise the use of ICUs, due to their high cost or bed shortage. They debated that IMCUs could decrease mortality and ICU readmission rate, and allow a better use of health resources and better patients' comfort.

In a retrospective analysis of prospectively collected data, Weissman et al. found that long-term patients have a significant impact on ICU bed utilisation (2000) and suggested that some of the long-term patients could be cared for in IMCUs. Beck et al (2002) who stratified late (20.00 h to 7.59 h) and early (8.00 h to 19.59 h) ICU discharges by destination, found that late discharge to the hospital wards was associated with a higher risk of post-ICU mortality than late discharge to IMCU, but the wide confidence interval for the IMCU group suggested that the sample size may have been too small to estimate precisely the magnitude of this association (Beck 2002). Another study on 5,805 patients treated with high intensity of care in 89 ICUs in 12 European countries (EURICUS-I) found the following factors associated with post-ICU mortality: physiological reserve before admission in the ICU, type of illness, intensity of care required at discharge, and the clinical stability and/or the grade of nursing dependence at discharge (Iapichino 2003). The sensitivity analysis on hospital mortality of patients discharged to intermediate care units (present in 24% of hospitals) showed a better outcome than that of patients discharged to the ward. In a before-after study on patients having elective abdominal aortic aneurysm surgery, Cleary et al. (2006) found that providing IMCUs improves ICU beds turnover and reduces ICU costs. However the costs saved in the ICU had to be offset against the cost related to IMCUs, making the economical benefit uncertain.

A recent meta-analysis found a relationship between increasing intensive care severity of illness and risk of readmission to ICU (Frost 2009), and the effect was the same regardless of the time of measurement of severity of illness (at admission to ICU or at discharge from ICU). Unfortunately the destination of ICU discharged patients was not assessed. The authors concluded that further research is required to allow the interventions for preventing ICU readmission.

Studies that do not support the implementation of IMCUs:

In their editorial mentioned above, Vincent and Burchardi () also bring arguments against the use of IMCUs mentioning that: i) there is no evidence of cost-effectiveness improvement; ii) other authors showed that IMCUs opening did not reduce the demand for ICU beds; iii) if the major economic argument in favour of IMCUs is the decrease in staffing levels, the nurse/patient ratio would still be high (1:3 or 1:4) and hence the cost benefit uncertain.

Vincent and Burchardi concluded that IMCU does not offer significant advantages on effective ICU admission and discharge strategies.

Moreno et al. (2001), who performed a multivariate analysis on the EURICUS II database using SOFA to measure organ dysfunction/failure and NEMS for nursing workload on the last ICU day, showed that only residual organ dysfunction/failure, not NEMS, was associated with post-ICU mortality rate (Odd Ratio 1.30; 95%CI 1.10-1.53).

In a study comparing patients admitted to IMCU with low risk ICU patients (monitoring but no life-threatening therapy on day 1 and low risk - <10% - for receiving subsequent active life-supporting therapy), Junker et al. (2002) found that the patients admitted to the IMCU had a significantly higher hospital mortality than low risk ICU patients, despite a lower severity of illness measured by APACHE III. However, there were differences in the IMCU and ICU case mix. Interestingly, the length of stay of the patients admitted to intermediate care was significantly longer than that of low risk ICU patients.

Peelen et al. (2007) who studied patients ICU admitted with severe sepsis found that the presence of an IMCU was associated with greater in-hospital mortality. Among the possible explanation, the authors mention hospital case mix difference, unrevealed confounders but also the eventuality of premature discharge when an IMCU is available.

More recently Solberg et al. compared the changes in total hospital costs for ICU patients before and after the introduction of an IMCU (2008). They found that the mean total hospital cost per patient was significantly increased after the IMCU introduction. However multiple regression analysis showed that determinants of increased costs were surgical patient, TISS on the ICU admission day and ICU length of stay rather than the introduction of the IMCU.

It appears clearly from this review of the literature that the potential benefits of IMCUs remain uncertain.

Among the issues on IMCU that should be answered, the most striking are probably the following:

- Does IMCU decrease the hospital mortality rate of ICU patients?
- Does IMCU allow earlier ICU discharge and hence improve patients flux through the ICU and reduce ICU cost?
- Does IMCU permit a reduction of ICU readmissions?

We propose to address these issues in a large multinational, multicentre study. .

NOTE

The difficulty in measuring resource utilisation and comparing results across different ICUs and countries is demonstrated by the lack of prediction models on resource utilisation, in comparison with the wide literature devoted to outcome prediction models (SAPS, APACHE, and MPM systems) (Knaus 1985, 1991, Le Gall 1993, Lemeshow Klar1994, Lemeshow Le Gall 1994, Metnitz 2005, Moreno 2005).

To overcome difficulties in resource utilisation measurement, the Length of ICU and/or Hospital Stay (LOIS or LOHS) have been proposed as surrogate markers of resource use, because pertinent and relevant even across different ICU's or countries (Stricker 2003). Nevertheless, LOIS and LOHS for a patient with a given severity of illness may be influenced by the structure (availability of intermediate care beds, percentage of hospital beds devoted to intensive care), as well as by organisational (number of physicians per bed, nurse/patient ratio) or other patterns (hospital discharge facilities, end of life habits) associated. Really, the models created in the past to predict LOIS/LOHS produced disappointing results and were often difficult to adopt (Angus 1996, Woods 2000, Sirio 2002, Rapoport 2003, Render 2005, Perez 2006). Furthermore, the LOIS/LOHS may be influenced by the performance of the ICU (patients with high severity of illness will have long ICU stays in an ICU where they survive, or they can stay a short time in another ICU where they die). Finally, the LOIS/LOHS seem to change over time (Rosenberg 2000, Moran 2008).

A recently published method to compute patient severity-adjusted resource use for individual ICUs was developed on the SAPS 3 database and considered LOIS of surviving patients per SAPS 3 stratum (Rothen 2007), but not LOHS or factors possibly influencing LOIS/LOHS.

Primary aim:

To assess whether the patients admitted to ICUs with availability of IMCU have lower hospital mortality than those admitted to the ICU without availability of IMCU.

Secondary aims:

To compare Lengths Of ICU and Hospital Stay (LOIS and LOHS, respectively) of patients admitted to ICUs with or without availability of IMCU. The LOIS will be used as a surrogate of ICU costs.

Since, in terms of cost, LOS in the IMCU is not equivalent to LOS in ward or ICU, the possible decrease in the number of ICU days will not reflect an equivalent cost reduction.

Hence, to assess the influence of IMCU on cost it will be necessary to determine the cost ratio between ICU and IMCU. This will be obtained by gathering information about staffing and number of beds of both ICU and IMCU of each hospital.

Remark: Some could argue that a top-down approach using cost block method as described by Edbrooke et al. () should be preferred to assess cost more precisely. However these economic parameters are rather difficult to collect, they may be inaccurate (Edbrooke 1999, Brazzi 2002) and may vary markedly among countries. Moreover the main difference, for the same level of care, between ICU and IMCU is physicians and nursing staff use. Hence, ICU and IMCU length of stay will adequately reflect the influence of IMCU on physician and nursing staff use. It was therefore decided to opt for the length of stay approach that seems more appropriate to assess the influence of IMCU in different countries.

To assess the influence of IMCU on the rate of ICU readmissions.

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