

INTRODUCTION

The introduction of advanced technologies, the increasing number of the elderly, and the severity of cases have resulted in increasingly expensive intensive care, making the clinical effectiveness and cost effectiveness of intensive care units (ICUs) aspects of utmost importance in the care of critically ill patients. ⁽¹⁾

Historical overview:

The speciality of critical care have developed with the recognition that patients with acute life-threatening illnesses or injuries were best treated in a geographically distinct area of the hospital, intensive care unit (ICU) is the designated location for the care of the sickest and most unstable patients in a given hospital. These units are among the most richly staffed in the hospital. Indeed , Florence Nightingale, perhaps the first ICU nurse , first recognized the distinct advantages of caring for and monitoring wounded British soldiers as close as possible to the nursing station during the Crimian War of the 1850s ⁽²⁻⁶⁾.

Indeed, modern ICUs now serve as a focal point in the complex network of the hospital environment, interacting with virtually every other unit in the hospital. Moreover, there is a growing trend for the development of the " ICU without walls" concept, as most critical care teams are involved with outreach programs, telemedicine, and rapid response systems ⁽⁷⁻¹⁰⁾.

Financial loads of the ICU:

There is no doubt that critical care medicine continues to be an important speciality. The United States currently spends approximately 16% of the gross domestic product (GDP), (nearly \$2.3 trillion) on health care, which represent approximately \$7400 per person per year. Approximately 1% of the GDP is spent on intensive care services ⁽¹¹⁻¹⁴⁾. At the same time, the number of ICU beds in the US continues to grow at a rapid pace, with nearly 15% of all hospital beds categorized as ICU beds ⁽¹⁵⁻¹⁷⁾.

Several factors are believed to be responsible for this increase. For example , the US population is growing older, and patients are living longer, even in the face of diseases that were previously considered universally fatal. In addition, hospitalized patients are becoming more dependent upon the use of invasive devices and technology. However, this story is far from complete, a very different picture emerges outside of the United States. For example, in the United Kingdom, ICU beds account for only 2% of the total hospital beds, as only the most critically ill patients are admitted to the ICU in the United Kingdom and Western Europe ⁽¹⁸⁾.

Definition of an ICU bed:

Several studies have shown that there is significant variation between countries on the exact definition of an ICU bed, which also may for some extent explain the differences in the ICU beds as a function of total hospital beds between different countries⁽¹⁹⁾. In general, the ICU bed is defined as the bed that can support the critically ill or injured patients, including ventilator support⁽²⁰⁾.

Indications for ICU admission:

Intensive care unit(ICU) or critical care unit (CCU) is a special department of a hospital or health care facility that provides intensive care medicine. Intensive care units cater to patients with the most severe and life threatening illnesses and injuries, which require constant, close invasive monitoring and support from specialist equipment and medication in order to ensure normal body functions. They are staffed by highly trained physicians and critical care nurses who are specialized in caring for seriously ill patients. Common conditions that are treated within ICUs include trauma, multiple organ failure, and sepsis⁽²¹⁾.

Requirements for establishing an ICU:

Equipments and systems; non- human resources (logistics):

Common equipments in an ICU includes mechanical ventilators to assist breathing through an endotracheal tube or a tracheostomy tube, cardiac monitors including those with telemetry, external pacemakers, defibrillators, dialysis equipment for renal problems, equipment for the constant monitoring of body functions, a web of intravenous lines, feeding tubes, nasogastric tubes, suction pumps, drains, and catheters, and a wide array of drugs to treat the primary condition(s) of hospitalization. Medically induced comas, analgesics, and induced sedation are common ICU tools needed and used to reduce pain and prevent secondary infections. Also, there is Bed Head Unit/Panel, Medical Rail System also known as Wall Utilizer.⁽²²⁾

Quality of care; (personal):

The ICU brings together physicians, nurses, pharmacists, and allied health providers from a variety of backgrounds, including surgery, anaesthesiology, internal medicine, emergency medicine, and pediatrics to care for the critically ill patients. With the adjustment of severity of illnesses, demographic variables and characteristics of different ICUs (including staffing by intensivists), it was found that higher ICU staffing was significantly associated with lower ICU and hospital mortality rates. A ratio of 2 patients to 1 nurse is recommended for a medical ICU, in contrast to the ratio of 4:1 or 5:1 typically seen on medical floors. This varies from country to country, e.g in Australia and the United Kingdom most ICUs are staffed on a 2:1 basis (for high dependency patients who require closer monitoring or more intensive treatment than a hospital ward can offer) or on a 1:1 basis (for patients requiring very intensive support and monitoring; for example, a patient on mechanical ventilator with associated anaesthetics or sedation such as propofol, midazolam and use of strong analgesics such as morphine, fentanyl and/or remifentanyl)⁽²³⁾.

Efficiency of bed utilization:

The national health services (NHS) has changed over the last 10 years, and with the recent financial downturn, hospitals are being challenged to provide high-quality patient care with limited resources. Moreover, clinicians and managers are expected to meet four-hour targets, where no patient would wait more than four hours in an emergency department (ED) from arrival to admission to a bed in the hospital or discharge, with zero tolerance for hospital-acquired infections (HAIs), both of which are associated with patient average length of stay (ALOS)⁽²⁴⁻²⁸⁾.

Efficient utilization of beds in the ICU depends mainly on the bed occupancy rate and the average length of stay in the ICU. High bed occupancy in the ICU is associated with prolonged admission waits from the emergency department (ED)⁽²⁹⁾. The latter can be reduced by availability of more empty beds, which requires reducing ALOS that in turn requires increased, yet appropriate, discharges. For a given period, the bed occupancy rate gives the relation between the supply and demand, which means that, the higher the occupancy, the less the number of beds required to satisfy a given level of demand⁽³⁰⁾.

Generally, a primary goal in intensive care is to decrease length of stay when medically appropriate in order to both improve the quality of medical care and reduce cost and excess use of resources. Although factors that affect length of stay and outcomes of care in the ICU have been studied extensively, the conclusions reached have not been reviewed to determine whether they reveal an organizational pattern that might be of practical use in reducing length of stay in the ICU. Appropriate stay which is considered to be up to typical, valuable, efficient, and customized to the patients' actual needs would improve hospital productivity, reduce waiting lists, and satisfy financial constraints without compromising the quality of care^(31,32).

Pattern of utilization of ICU services:

Esserman et al, in USA, during the year 1995, found that 32% of ICU resources were spent caring for patients who survived less than 100 days after discharge from the hospital⁽³³⁾.

Fakhry et al, in USA, during the year 1996, found that 70% of patients with stays longer than 2 weeks reported less than 50% functional recovery. Of the patients who were employed before ICU admission, less than 30% had returned to work⁽³⁴⁾. Furthermore, in several studies, the mortality of patients with ICU admissions lasting 14 days or longer was estimated to be nearly 50%^(35,36).

In a study conducted by Hughes et al, in Canada, reported in year 2001, of 323 patients with ICU stays of 30 days or more, these patients were found to occupy 15.7% of the total ICU bed days, although they represent only 1.6% of patients admitted to the ICU⁽³⁷⁾.

In a prospective observational study, during the year 2003, in New Zealand, Sticker et al, found that whereas only 11% of patients admitted to the ICU stayed for more than 7 days, these patients used more than 50% of ICU resources⁽³⁸⁾.

In Egypt, a study was done in the respiratory ICU of Zagazig University Hospital during the year 2010, revealed that 200 cases were admitted during the study period with a mean length of stay of 7.2 days. Analysis of outcome of the cases showed that 70 patients (35%) were transferred to chest ward, 61 patients (30.5%) died and 54 patients (27.0%) were discharged to home. Concerning the outcome on using mechanical ventilation, the mortality rate among mechanically ventilated patients was 52.5%, while in non-mechanically ventilated patients it was 47.5%⁽³⁹⁾.

Another study was carried out during the year 2011 in the Third ICU of Alexandria Main University Hospital revealed that the total number of admitted cases who required mechanical ventilation during this year was 221 cases and the duration of patients' stay in the ICU ranged from one day to 70 days with a mean duration of 14.34days⁽⁴⁰⁾.

Factors affecting length of ICU stay:

Although, factors associated with longer stay may include age and type of admission. Age itself was not a strong predictor for length of stay, and older age was not associated with a longer stay in the ICU. The assumption that older age might correlate with a longer stay in hospital or in the ICU has been researched before. Analysis of a cohort of about 10.000 ICU patients in

1998, in the Netherlands, showed that age was less important as a predictor of high-weighted hospital days, than presence of infection or ventilator dependency at 24 hours. Besides this, long ward stays before ICU admission and lack of full time ICU physician involvement in care increased the propability of long ICU stays. Another factor associated with prolonged ICU stay was the type of admission. The largest proportion of long stay patients comprised non-elective admissions, specially medical admissions⁽⁴¹⁾.

Similar results were observed in a prospective study in Saudi Arabia analysed various potential predictors for associations with prolonged ICU stay (≥ 14 days) in a medical-surgical ICU and found that as well as non-elective admissions, readmissions, respiratory or trauma-related reasons for admission, and first 24 hours evidence of infection, oliguria, coagulopathy, and the need for mechanical ventilation or vasopressor therapy had a significant association with long stay⁽⁴²⁾.

Identification of predictors of prolonged stay in ICU may help in determining the proper timing of ICU discharge. It may also suggest the need for intermediate care units for ICU patients who are stabilized and no longer need critical care, but are not stable enough to be discharged to the floor. Reduction of inappropriate hospital patient stay for hospitals has been an important issue for health care policy-makers and practitioners⁽⁴³⁾. In many economically developed countries, the average length of stay of hospital patients has been decreasing for decades because they are following an international trend of continuing reductions in length of stay⁽⁴⁴⁾.

Inappropriate hospital patient stay is defined as a patient day of stay that does not require continuous and active medical, nursing or paramedical treatment provided by hospital services.⁽⁴⁵⁾

Inappropriate hospitalization days are recognized as an important indication of the misuse of health care services and indicates inefficient utilization of hospital resources^(46,47).

Implications of prolonged ICU stay:

Prolonged ALOS has been identified as a possible contributory factor to an increased risk of developing HAIs and thrombo-embolism, which have significant health, and potential financial implications for patients ⁽⁴⁸⁾ .

Also, prolonged ICU stay can adversely affect the health status by increasing the risk of complications, and possibly mortality ⁽⁴⁹⁾ .

Operationally, it impacts upon ICU bed availability and results in cancellation of elective surgeries, leading to long waiting times. The lead-time, defined as the time spent on the ward before ICU admission, is also prolonged, a factor known to affect patient outcome. These issues become all the more relevant in the context of the ongoing global shortages of the critical care nursing staff ⁽⁵⁰⁾ .

Reducing ALOS and increasing safe discharges would increase bed availability and help achieve the four-hour target while reducing the health risks ⁽⁵¹⁾ .

There is a need for optimizing an efficient distribution and use of ICU beds. Collection, analysis, and interpretation of relevant objective data on the utilization of ICU beds will help plan for reducing the length of ICU stay and facilitate covering more patients who require this care ⁽⁵²⁾ .

Post ICU discharge:

Transitions of care within the hospital have been identified as periods where patients are susceptible to harm and severe adverse events: the two largest transitions of care periods occur at discharge from the intensive care unit (ICU) and discharge from hospital. Since these processes liberate both hospital and ICU beds, it is no surprise that these events are intimately linked to health care economics and resource allocation. Generally the discharge process is associated with changes to the patient's treatment team, medication and level of care. Specifically, at ICU discharge these changes represent a large drop in the level of care, where ICU patients are transitioned from a highly monitored ICU ward to the lower care general ward area. Since the ICU patient is critically ill and already poses a higher baseline mortality rate, it is no surprise that ICU discharge is associated with a spectrum of adverse events; ranging from death to readmission to medical emergency team activation (MET) ⁽⁵³⁻⁵⁵⁾ .

In the interest of maintaining a standard of high quality care and patient safety there has been motivation to identify risk factors that are associated with increased mortality and readmission post ICU discharge. However, to date there has not been a formal systematic assessment of risk factors and clinical decision-making tools associated with adverse events post ICU discharge ⁽⁵⁶⁻⁵⁸⁾ .

There have also been attempts to formalize this process by developing a clinical decision-making tool, to support the ICU discharge process ⁽⁵⁹⁻⁶¹⁾ .

One of the identified areas for improvement in health care quality and safety is inefficient delivery of care, that can result in adverse events and harm. The Harvard malpractice study, during the year 2003, found that adverse events occur in 3.7% of

patients discharged from hospital and approximately 1% of these events are avoidable. The most common adverse events were related to drug complication, wound infection and technical complications, with all of these events occurring more frequently in patients older than 64 years of age. Ultimately, the study found that overall management errors accounted for 58% of all adverse events and were, in all instances, preventable⁽⁶²⁾.

A similar Canadian study, during the year 2006, reported an overall 7.5% adverse event rate, with 36.4% being preventable, and 20.8% resulting in mortality. These events result in an extra 1521 hospitalization days, and that management errors were the primary contributor. These studies highlight the need to improve patient quality of care and safety, since this would function to not only improve health care, it would also reduce costs associated with inefficient care⁽⁶³⁾.

Risk factors associated with adverse events post-ICU discharge consistently include increasing age, ICU length of stay, male gender and the presence of patient co-morbid conditions⁽⁶⁴⁾.

A recent meta-analysis by Frost et al, reported in year 2009, identified a relationship between increasing severity of illness and the risk of readmission regardless of what point in time, the measurement was taken during the ICU stay. However, this meta-analysis was focused solely on the outcome of readmission and did not take into account mortality and MET team activation⁽⁶⁵⁾.

Ultimately ICU discharge is a clinical decision, which should incorporate clinical information and current knowledge to produce an evidence-based decision. There are numerous tools or scores that function to aid in the clinical decision making process in specific circumstances. Classic examples of these include the Acute Physiology and Chronic Health (APACHE) scoring system, and the Ottawa ankle rules which were developed to address the issue of radiography in acute ankle injuries presenting to an emergency department, this rule now has been recognized and implemented in daily clinical practice internationally⁽⁶⁶⁻⁶⁸⁾.

There have been attempts to develop a score that can aid with ICU discharge decision-making. The Stability and Work load Index for Transfer (SWIFT) score is an ICU discharge score that use the following variables for assessment: ICU length of stay, patient admission source, Glasgow Coma Scale (GCS), partial pressure of oxygen in arterial blood[PaO₂] / fraction of inspired oxygen [FIO₂], and nursing demand for complex respiratory care. This score was validated over a period of one year and was found to have higher discrimination power for ICU readmission than the APACHE III score. However, it has the limitations in that it was developed to predict readmission but not mortality, missing half of the adverse event spectrum⁽⁶⁹⁾.

ICU readmission:

Early discharge from ICU is not without risk. If patients requiring high intensity care are discharged before they can be safely cared for in a lower acuity care environment, they are at risk for both complications and delayed recognition of clinical deterioration. The former can result in the need for unplanned ICU readmission, the latter can result in patient death.

Patients readmitted to ICUs have higher risk-adjusted mortality and lengths of stay⁽⁷⁰⁻⁷²⁾. The actual increases in mortality and lengths of stay may be modified by contextual factors such as bed occupancy rates and patient inflow volumes^(73,74). In addition, ICU readmission also places stress on patients and families.

Determining who is ready for ICU discharge is a daily challenge for ICU leaders, especially in units with high occupancy rates. Traditionally these decisions are made by attending physicians, in collaboration with other members of the ICU care team⁽⁷⁵⁾. Due to the highly subjective nature of these decisions, there is considerable variability in determining discharge readiness⁽⁷⁶⁾. There are few data on why patients deteriorate after ICU discharge, and differentiating problems present at the time of discharge from those that originate after discharge oftentimes is not possible. In the absence of these informations, it is generally assumed that the shorter the time between discharge and readmission or death, the more likely the patient was not 'ready' to be discharged from the ICU. As a result, 48 hours has historically been considered the primary timeframe for evaluating the quality of ICU discharge⁽⁷⁷⁾.

Several studies have evaluated post-discharge patients and identified variables that predict their complications^(78,79). Previously identified predictors of death or readmission include duration of ICU LOS, Glasgow Coma Scale (GCS) score at the time of ICU discharge, mean arterial blood pressure and ICU admission source⁽⁸⁰⁾.

The definition of 'ICU readmission' varies from either in the first 24 hours, to over the next two days or even whether the patient comes back during the entire period of admission^(81,82).

Implications of ICU readmission:

Intensive care unit readmissions are associated with mortality, cost, and length of stay. They may also capture a component of hospital efficiency through optimal patient flow management, and have been proposed as an appropriate measure of the quality of ICU care⁽⁸³⁻⁸⁵⁾.

However, little is known regarding the epidemiology of ICU readmissions in the United States: how commonly they occur, when, and where they occur, or whether rates have changed over time. Past studies in small numbers of ICUs^(86,87), using heterogenous definitions of ICU readmission have estimated rates from 4.6-13.4% and a recent larger study in Australia examined patient risk factors for ICU readmission. Thus, although ICU readmission rate is a promising measure for assessing patient triage decisions and ICU performance, its use as a quality metric depends on a better understanding of their incidence and the hospital-level factors associated with their occurrence⁽⁸⁸⁾.

Utilization of ICU resources:

Quality of care and patient safety are areas of improvement that have a large effect on health care, and consequently on health care budgets and resources ⁽⁸⁹⁾ .

A significant proportion of hospitalized patients experience harm from adverse and avoidable events, which translates into increased health care burden and ultimately cost. Therefore, maximizing quality of care and patient safety functions to improve health care and patient wellness, as well as minimizing harm and cost burden on the health care system ^(90,91) .

The expected lifetime and mean age of people in the western world is steadily increasing. The total population of the world will have grown by 30% by the year 2035, meanwhile, the number of people over 65 years will increase by 7.5% to 13.5% of the total population. In the Netherlands in 2035, 25% of the population will be over 65 years of age, in contrast with 15% of the population this year. Consequently, these projections imply a rise in the consumption of ICU resources by the elderly, since older critically ill patients take more time to recover ⁽⁹²⁻⁹⁵⁾ .

The care delivered in hospitals has changed markedly over the past decades. Indeed, as a result of clinical innovations, the use of practice guidelines, care protocols and early inpatient rehabilitation, length of hospital stay has shortened during this period ⁽⁹⁶⁻⁹⁸⁾ .

Although, a similar decrease in the length of stay in ICUs might be expected, conflicting results have been reported. In particular, long stay patients may consume a disproportionate amount of ICU resources. It is hypothesized that the increasing age of the population could lead to older patients in ICUs and to a rise in the number of long-stay patients. This would thereby inevitably cause a disproportional rise in the use of ICU resources ^(95,99-101) .

There are many measures to assess ICU resource utilization. A simple and readily available measure is ICU length of stay (LOS). Cost analysis studies have found that the ICU cost per day per patient is remarkably consistent across most diagnoses. Therefore, ICU LOS has been used as a surrogate measure of resource utilization in the ICU. Another measure is the duration of mechanical ventilation, as this is one of the most common procedures in the ICU ⁽¹⁰²⁻¹⁰⁵⁾ .

Justification of work:

The indications for admission to the ICU remain poorly defined and the identification of the ideal patient who can benefit from intensive care is extremely difficult. This fact and the expansion of clinical practice have led to the inappropriate use of ICU resources.

This research work is planned as a prospective survey to determine the influence of some quality indicators such as rate of admission & readmission, bed occupancy rate, the need for mechanical ventilation, and length of ICU stay on the assessment of health services utilization and this will help in establishing guidelines for admission, discharge and triage of adult ICU patients which is of utmost importance and is supported by literature, with subsequent appropriate utilization of ICU resources that will lead to optimizing health care cost and quality of care.