ORIGINAL ARTICLE

Utilization of Intensive Care Unit Resources in Severe Acute Pancreatitis

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ABSTRACT

Context Severe acute pancreatitis is a common abdominal emergency; it is a potentially fulminant disease with no specific treatment. The incidence of severe acute pancreatitis is increasing, but the overall population mortality rate has remained unchanged as the case fatality rate has decreased over time. The hospital mortality rate of patients with severe acute pancreatitis has dropped to 20% even in the most severe forms of the disease. The prolonged course of severe acute pancreatitis, associated with multi-organ failure and other complications, is a considerable strain on intensive care unit (ICU) resources.

Objective To analyze the extent of ICU resources consumed by the severe acute pancreatitis patient group as well as the expenses of the treatment and differences in the costs of survivors versus patients who die after a prolonged stay in the ICU.

Design Retrospective study.

Participants All patients with severe acute pancreatitis treated in the general ICU of Helsinki University Hospital from 1995 to 2005 (245 patients; 169 (69.0%) with alcohol-induced severe acute pancreatitis).

Results The mean length of the ICU stay was 17.4 days and severe acute pancreatitis patients constituted 17.0% of all ICU days. The mean hospital cost per patient was 86,856 Euros. The overall mortality rate was 26.1% and the hospital costs of the non-survivors seemed to be higher (although not significantly) than that of the survivors.

Conclusions Optimal early care in order to decrease the onset of organ dysfunctions and better prognostic models to identify non-surviving severe acute pancreatitis patients earlier could lead to considerable savings in the overall use of ICU resources.

INTRODUCTION

Severe acute pancreatitis, a disease with high mortality, is associated with multi-organ failure and the development of local pancreatic complications such as abscesses, infected necrosis and the formation of pseudocysts. Patients with severe acute pancreatitis and its associated complications form a great challenge to the health care system necessitating admission to a high dependency or intensive care unit (ICU), often for a prolonged period associated with a significant strain on resources.

The incidence of severe acute pancreatitis is increasing in many countries, mostly explained by higher alcohol consumption, as alcohol is a major contributor to the disease [1]. The incidence of acute pancreatitis varies between 5 and 80 per 100,000 people, with the highest incidence seen in the United States

and Finland [2]. About 30% of acute pancreatitis cases are severe. The mortality rate of these patients has been in the range of 30-50% and a mean hospital length of stay of greater than one month, attesting to the severity of pancreatitis at this end of the spectrum [3].

Today, the hospital mortality rate of patients with severe acute pancreatitis has dropped to about 20% even in the most severe forms of the disease [4]. In a review article based on 18 reported population-based studies of the first attack of acute pancreatitis, the case-fatality rate has decreased over time (1966-2005) [1]. Because of the prolonged course of severe acute pancreatitis, however, the strain of this patient group on ICU resources is considerable. Thus, efforts to decrease the incidence of severe acute pancreatitis, the development of better prognostic models and more effective treatment might not result only in a better outcome for the patient, but also produce enormous savings in health care expenses.

Although ICU patients comprise a small proportion of the total patients in the hospital, they account for a significant amount of hospital resources. In a cost-conscious society, it is necessary to address the overall performance of ICUs. This study was designed to analyze the patients with severe acute pancreatitis treated in the ICU of Helsinki University Central Hospital, Finland. More specifically, the aim of this study was to analyze how much of ICU resources are used by this particular patient group. In addition, we analyzed the expenses of treating severe acute pancreatitis in the ICU and whether there was a difference in the costs of survivors versus patients who die after prolonged stay in the ICU.

METHODS

In this retrospective study, we analyzed the hospital records of all patients with severe acute pancreatitis treated in the general ICU in Helsinki University Central Hospital from 1995 to 2005.

Patients

During the 11-year period, a total of 245 patients with severe acute pancreatitis were treated in the ICU. The diagnosis of pancreatitis was based on diagnostic and prognostic laboratory tests including a CT scan in all patients. The indication for ICU treatment was severe acute pancreatitis with organ dysfunction. Epidemiological data, the criteria for severe acute pancreatitis and the definitions of organ dysfunctions used at our hospital have been published previously [5, 6]. A total of 92 patients (37.6%) in this group were treated in the ICU after 2002, and they constituted the population used for the analyses of the treatment expenses because the Euro has been the currency in Finland since 2002.

Of the 245 patients included, 210 (85.7%) were male. The mean age of the patients was 47±12 years. The majority of the cases were alcohol-induced (169; 69.0%).

Cost Analysis

In general, the costs of patient care can be divided into hospital costs (direct and indirect costs) and community costs (loss of productive work/sick leave, etc.). At Helsinki University Central Hospital, the hospital cost of a treatment period for every patient is based on a standard daily cost (in the ward, ICU, etc.) multiplied by the number of days in the hospital with specific costs added for operative and diagnostic (CT scan for example) procedures and exceptionally expensive medications. The daily cost in a ward or ICU is based on the annual calculation of the actual costs (direct and overhead) of the service and includes personnel costs, equipment, medication, etc. For each Diagnosis-Related Group (DRG), the mean hospital cost is calculated annually based on the true calculated costs for that group in the previous year reflecting the utilization of resources spent for the care of an individual patient. If the patient's true costs fall within 2 standard deviations (SD) of the mean costs in that specific DRG-group,

the mean cost will be used for the billing sent to the home county of the patient. If the costs are outside 2 SD, then the actual cost will be used for billing.

The cost of one day in the ICU in Helsinki University Central Hospital is 3,830 Euros per patient. Personnel costs constitute about 47% of the total cost, medicine and related medical consumables 25%, and laboratory tests and radiological examinations 4%. The remaining 24% of the cost consists of administrative and infrastructure costs and included building maintenance, information technology, insurance and capital interest costs.

STATISTICS

Mean, standard deviation (SD), and frequencies were used as descriptive statistics. A comparison of continuous variables was performed with an unpaired Student's t test with statistical significance at the two-tailed 0.05 level. Statistical analyses were carried out using Microsoft Office Excel 2007 and GraphPad Prism software (version 4.0; San Diego, USA).

RESULTS

The total length of the ICU stay of patients with severe acute pancreatitis was 4,438 days constituting 17.0% of all ICU days. Their mean±SD length of ICU stay was 17.5±15.6 days. Renal replacement therapy was required in 99 (40.4%) cases of this patient group. The mean±SD hospital cost per severe acute pancreatitis patient was 86,856±79,896 Euros (7,990,756 Euros for the 92 patients in the period of time from 2002 to 2005).

Twenty patients (21.8%) underwent surgical interventions in the period from 2002 to 2005; the total cost of the surgical interventions was approximately 12,500 Euros per patient (3.1% of total ICU costs).

The overall mortality rate was 26.1% (64 patients; 23 in the period of time from 2002 to 2005). The non-survivors consumed 29.5% of the ICU days (1,310 days) and 28.3% of the hospital costs (2,261,962 Euros for the 23 non survivors in the period of time from 2002 to 2005) of all severe acute pancreatitis patients treated in the ICU. Their mean hospital cost per patient was about 15,000 Euros higher than that of the survivors (98,346±99,596 *vs.* 83,026±71,267; P=0.424). In most of the non-survivors, death occurred after a prolonged stay in the ICU, even if this difference did not reach statistical significance (20.5±20.9 *vs.* 16.5±13.1 days; P=0.074).

DISCUSSION

As suggested in this study, patients with severe acute pancreatitis utilize a considerable proportion of university hospital ICU resources. They require highly demanding continuous care, special equipment and therapeutic interventions such as mechanical ventilation, renal replacement therapy and invasive monitoring, for example. However, the majority of expenses are constituted by personnel costs as they account for nearly half of all expenses. The increased need and utilization of resources in the ICU derives from the high incidence of multiple organ dysfunctions requiring complex monitoring and care, particularly true in patients with severe acute pancreatitis. All patients included in this study were treated in the ICU because of the dysfunction of one or more organ systems. The mean SOFA (Sequential Organ Failure Assessment) score of the severe acute pancreatitis patient group in our hospital at one week time point is approximately 9, as has already been reported by Halonen *et al*. [6]. Only a minority of the costs in our study were due to surgical intervention (3.1% of total ICU costs). As pointed out by this study, the expenses of the non-survivors are higher than survivors (about 15,000 Euros per patient, even if the difference does not reach the significant level). This is probably due to a longer ICU stay among non-survivors.

Although the management of severe acute pancreatitis is expensive, it is justified by the excellent outcome in terms of quality of life [3, 7]. Many different strategies could be adopted in order to diminish this load and to accomplish considerable savings in the overall use of ICU resources. First of all, efficient preventive strategies to reduce the overall incidence of acute pancreatitis are

needed. This is a continuing challenge as alcohol consumption seems to be increasing. For instance, the increase in alcohol consumption in Finland was 11% between 2003 and 2006. This increase is partly explained by reduced alcohol taxes. In Finland, where alcohol is sold through a state-run monopoly, alcohol taxes were cut by one-third in March 2004. The trend is alarming, since about 70% of pancreatitis patients in Finland are alcohol-induced. As alcohol is a major contributor to severe acute pancreatitis, preventative intervention should be a major concern.

Secondly, optimal early care of severe acute pancreatitis in order to decrease the onset of organ dysfunctions and other complications is a key point. Evidence-based recommendations for the management of critically ill patients with severe acute pancreatitis have been addressed by an international consensus conference [8]. In their statement, a total of 23 recommendations were developed to provide guidance to critical care clinicians when caring for a patient with severe acute pancreatitis. Accordingly, a study by Mofidi *et al.* suggested that patients with severe acute pancreatitis can be managed according to the revised guidelines of the British Society of Gastroenterology resulting in a lower mortality rate [4]. Most recently, a review article by Besselink *et al.* updated the treatment procedure of severe acute pancreatitis and suggested that the timing of intervention is becoming increasingly important in severe acute pancreatitis management [9]. Although no specific treatment for severe acute pancreatitis exists, replacing the massive fluid loss in the early disease phase is critical and determines the prognosis. Early enteral nutrition for the treatment of severe acute pancreatitis has been shown to be important [10, 11]. Antibiotic prophylaxis has been associated with decreased mortality and infected pancreatic necrosis in some studies [12]. However, a recent meta-analysis suggested that prophylactic antibiotic administration is not an appropriate treatment strategy in patients with severe acute pancreatitis, and it

should be limited to patients with pancreatic necrosis [13]. Therefore, further studies are required in order to provide adequate data and to define the role of antibiotic prophylaxis in patients with severe acute pancreatitis [14]. Some of the severe acute pancreatitis patients develop increased intra-abdominal pressure, associated with the onset of early organ failure, increased mortality and a long-term stay in the ICU. Organ dysfunction may be avoided, and patients potentially benefiting from decompressive surgical operations may be recognized by frequent measurements of intra-abdominal pressure during intensive care [15]. Subcutaneous anterior abdominal fasciotomy is a promising novel surgical technique for abdominal decompression [16]. In addition to decompressive laparotomy, infected pancreatic necrosis, abscesses or pseudocysts are other indications for open surgery in severe acute pancreatitis [17]. Even when indicated, surgery in severe acute pancreatitis is frequently delayed or even replaced by minimally invasive surgical methods.

To better understand the pathophysiological mechanisms involved in pancreatitis and its related systemic inflammatory response, the development of new treatment strategies would help. For instance, progress in understanding the role of cytokines could provide opportunities to use immuno-modulatory therapies to improve the outcome in severe acute pancreatitis [18]. In the future, enterally administered probiotics may also be used as a prophylaxis for reducing the incidence of infectious complications [9].

Thirdly, better prognostic models for identifying non-surviving patients earlier could lead to remarkable savings in ICU resources. Both therapy-associated and patient-related factors play a role in survival in severe acute pancreatitis, but there are only a few relevant methods for predicting fatal outcome. Many different scoring systems for the prediction of the prognosis of severe acute pancreatitis have been suggested [19]. Scores such as Ranson and Imrie can be used to determine whether the clinical course is likely to be severe, but these scoring systems are

inaccurate indicators of mortality in severe acute pancreatitis. In addition, most of the scoring systems for the severity of acute pancreatitis are complicated and consist of multiple factors. For example, 14 variables are required in APACHE II [20]. A simpler predictive model by Halonen *et al*. based on four variables (age, highest serum creatinine value within 60-72 h from primary admission, need for mechanical ventilation and chronic health status) was suggested in order to reach at least the same predictive performance as APACHE II [21]. Most recently, Ueda *et al*. suggested that a scoring system made up of only three items (i.e., serum blood urea nitrogen equal to or greater than 25 mg/dL, serum lactate dehydrogenase equal to or greater than 900 IU/L and contrast-enhanced computed tomography findings of pancreatic necrosis) could be simple and feasible for the prediction of severe acute pancreatitis at admission [22]. This novel scoring system seems to be competitive if compared to conventional scoring methods, but still more effort is needed to be able to develop a more accurate scoring system which could identify fatal outcome in severe acute pancreatitis patients at the early phase of the disease.

In addition to many different scoring systems for the prediction of severe acute pancreatitis, increased intra-abdominal pressure is also suggested to be a potential prognostic factor. Intra-abdominal pressure has been shown to be associated with the onset of early organ failure and is also reflected in increased mortality and fewer ICU-free days in patients with severe acute pancreatitis [15]. Accordingly, Rosas *et al*. suggested that intra-abdominal pressure is a useful, inexpensive and easy method of measuring the evolution and complications of acute pancreatitis [23].

Efforts targeted at improving treatment methods and developing consistent care for severe acute pancreatitis could result in savings in ICU resources and a decrease in overall expenses. Still, more accurate recommendations concerning the management of patients with pancreatitis, especially focused on critically ill severe acute pancreatitis patients is needed. A number of important questions which have not been answered to date using an evidence-based approach remains to be answered. Thus, further research is needed in associated relevant areas concerning the treatment and prognosis of severe acute pancreatitis.

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