Are we selecting appropriate admissions for intensive care following major abdominal surgery: A retrospective cohort study on outcomes of 1059 patients

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ABSTRACT

Background: Like any other medical treatment, The intensive care unit (ICU) is a limited resource that needs to be utilized appropriately. This study aimed to identify the outcomes of patients admitted to the ICU based on patient demographic and severity score parameters.

Methods: An observational retrospective cohort study of 1059 patients undergoing laparotomy who were admitted to the ICU was performed. Cases were sub-classified by the mode of admission and risk prediction scores and analyzed outcomes of mortality, ICU length of stay (LOS), and hospital LOS.

Results: The mean age of patients who did not survive was older than those who survived, and higher Acute Physiology and Chronic Health Evaluation (APACHE) II and Intensive Care National Audit and Research Centre Physiology Score (ICNARC) observed in patients who died. Emergency admission was also an indicator of increased mortality. Survivors APACHE II scores were the same if they were elective or emergency admissions, although Survivors ICNARC scores were higher in emergency than in elective admissions. Patients who did not survive had a longer ICU LOS stay than those who survived, whereas elective survivors had shorter ICU LOS than the emergency survivors. Regardless of this hospital LOS was the same for both elective and emergency survivors.

Conclusion: The most unwell patients had the highest risk prediction scores, were more often admitted in the emergency setting, required longer stays in ICU, and had less favorable outcomes. However, ICU did appear to expedite the hospital discharges of emergency patients to match their elective counterparts. Decisions around when and to which patients ICU is an appropriate intervention remains a difficult decision and one that cannot be made without full consideration of all aspects of patient factors.

Key Words: Acute Physiology and Chronic Health Evaluation, Intensive Care National Audit and Research Centre Physiology, laparotomy, length of stay, mortality

INTRODUCTION

Major abdominal surgery, both open and laparoscopic, are commonly performed operations in both emergency and elective settings. Such highly invasive procedures carry with them a significant investment, both in terms
of time and resources. It is estimated that 30,000–50,000 emergency laparotomies are performed in the UK each year, at the cost of approximately ≤13,000 per patient. Emergency laparotomy also carries a significant risk of fatality, and across the world, it is estimated that one in six patients will die within a month of this type of surgery. It is for this reason that many initiatives in the UK, and indeed across the world, are focused on reducing the morbidity and mortality with laparotomy, improving outcomes. The National Emergency Laparotomy Audit has been set up by the Royal College of Anesthetists to outline key standards to improve the quality of care for patients undergoing these procedures. One such standard is the use of a preoperative mortality and morbidity score founded on the principle of providing individualized risk assessment and subsequent individually tailored care. The most frequent surgically adopted of these is P-POSSUM, though later in the course of the patients care other scoring systems such as the Acute Physiology and Chronic Health Evaluation (APACHE) II and the Intensive Care National Audit and Research Centre Physiology Score (ICNARC) are utilized in critical care. The aim of this study was to review a series of data assessing outcomes after major abdominal surgery and identify demographic trends in how patients were treated.

**METHODS**

A retrospective cohort study of consecutive case series of intensive care unit (ICU) patients undergoing major abdominal operations between 2007 and 2015 was performed and cross-referenced with a database kept by the general surgical department. Patients whose data were conflicting between the two data sets were excluded from this study. There were no exclusion criteria based on age, gender, or type of surgery. Key outcome variables included mortality, age, nature of admission, hospital and ICU length of stay (LOS), APACHE II, and ICNARC Scores. Subsequent between groups, statistical analyses were performed using Student’s t-tests with a significance level of 0.05. There were no confounding variables or effect modifiers identified and no sources of bias.

**RESULTS**

One thousand and fifty nine patients were identified between 2007 and 2015 and no patients were excluded from the subsequent analysis. The mean age was 72.9 years (±15.5 years) and there were 524 female patients compared to 535 who were male. There were 182 deaths across all patients (17.15%). Two hundred and eighteen patients were admitted electively compared to 841 who were emergency admissions. The mean age of patients who died were older (77.25 years vs. 71.77 years, \( P < 0.01 \)) and had higher APACHE II and ICNARC scores compared to those who survived (17.9 vs. 12.3 and 20.0 vs. 12, respectively, \( P < 0.01 \)). Deaths were also more frequently as a result of an emergency admission rather than an elective one (19.9% vs. 6.9%). Perhaps interestingly, patients who died had a longer ICU LOS than those who survived (5.68 days vs. 3.6 days, \( P < 0.01 \)). The mean hospital LOS of all survivors was 21.08 days, regardless of the nature of their admission. Contrary to what would have been expected, there was no difference in hospital LOS between elective and emergency survivors (18.57 days vs. 21.84 days, \( P \) not significant), but elective survivors had a shorter ICU LOS than there emergency counterparts (2.87 days vs. 3.80 days, \( P = 0.02 \)). Survivors APACHE II scores were no different regardless of whether they were elective or emergency admissions (12.68 vs. 12.25, \( P = 0.2 \)), although there ICNARC scores were different (10.4 vs. 12.44, \( P < 0.01 \)). The APACHE II and ICNARC scores were consistently higher in patients who died compared to those that survived, regardless of their mode of admission (elective vs. emergency; APACHE II 14.47 vs. 18.18, \( P = 0.02 \) and ICNARC 12.67 vs. 21.63, respectively, \( P < 0.01 \)).

**DISCUSSION**

Advanced age is thought to be associated with a poorer prognosis in critically unwell patients. However, it is important to note that any studies involving outcomes of elderly patients in the critical care setting may be skewed due to selection bias, as particularly invasive treatments, including admission to intensive care, are often withheld in this cohort. The data from the 1059 patients who were admitted to the ICU showed those who did not survive were older than those who did survive (mean age 77.25 years vs. 71.77 years, respectively, \( P < 0.01 \)) and may imply a dramatic reduction in survivability in the seventh decade on a general population level. Similar findings are well-documented across the board in medical literature, with one particular study reporting that independent of the severity of illness, Acute Physiology Score, admission source, diagnosis and comorbidity, and age >70 years old is associated with an additional 2% increase in mortality. However, it is not simply chronological age that influences outcomes in elderly patients but rather the associated features such as degree of frailty and lack of physiological reserve that impact on “biological age”. In this way, age may be seen as a surrogate marker for frailty and may not be an independent predictor of mortality. Indeed, frailty, in this context relating to the functional status before admission to hospital, has been shown to be a very strong independent predictor of hospital outcomes amongst elderly patients and it is unsurprising that impaired functioning in daily life is more prevalent in the elderly. It is, therefore, unsurprising that the
Emergency Laparotomy and Frailty Study was launched in 2017, and confirmed that a Clinical Frailty Score >5 was associated with worse 30-day and 90-day mortality and morbidity as well as increased risk of complications, ICU LOS and overall hospital LOS.⁸

As described, the Acute Physiology and Chronic Health Evaluation (APACHE II) is one of several severity of disease classification systems used in the critical care setting in the UK. A recent systematic review concluded that APACHE II demonstrated the best and most consistent discriminator of individual outcomes of a varied group of patients undergoing laparotomy when used either pre or postoperatively.⁹ The data set investigated in this study revealed that patients who died had higher APACHE II scores compared with the survivors (17.9 vs. 12.3, \(P < 0.01\)). Similarly, the ICNARC score was higher in those who did not survive compared to those who did (20.0 vs. 12.0, \(P < 0.01\)). This result confirms what would be generally expected with more critically unwell patients having a lower survival probability. Similarly expected is those who were admitted as emergency patients showed higher mortality compared to their elective counterparts (19.9% vs. 6.9%, \(P < 0.01\)), which perhaps could relate to reduced opportunity for preoperative optimization among the emergency group.

In this data set, mode of admission made little difference to APACHE II scores in those who survived. In the emergency group, survivors APACHE II scores were not significantly different than those who were admitted in the elective setting (12.68 vs. 12.25, \(P = 0.2\)). This is not what was expected to be observed and is different from what is seen in other similar studies where APACHE II scores were higher in those with emergency admissions.⁹ However, mode of admission did change the ICNARC score, where we observed that survivors ICNARC scores were higher in the emergency patients than their elective counterparts (12.4 vs. 10.4, \(P < 0.01\)). This is more in keeping with what would be expected to be seen as it is known from above that those who were admitted as an emergency had less favorable outcomes. Does this, therefore, imply that in this dataset ICNARC has been shown to be a better prognostic tool than APACHE II? While the information here would seem to suggest this, there have been no other formal studies performed for comparison to validate this outcome. The closest similar evaluation that was found compared ICNARC to P-POSSUM and concluded that the ICNARC model was the superior risk prediction model when analyzed by ROC curve comparison and went on to discourage the use of APACHE II and favor the use of ICNARC in the emergency laparotomy setting.¹⁰ Further studies will be needed if this question is to be robustly answered.

It is not difficult to believe that the most unwell patients require the most intensive treatments and as represented above those with the worst risk prediction suffer the worst outcomes. It is, therefore, no stretch to understand that the most unwell also require additional time for input, here represented by ICU LOS. In this study, patients who did not survive, when not sub-divided by mode of admission, spent longer in the department than those who survived (5.68 days vs. 3.6 days, \(P < 0.01\)). When sub-classifying this further, it was also apparent that elective survivors had shorter ICU LOS than the emergency survivors (2.87 days vs. 3.80 days, \(P = 0.02\)). This reinforces the notion that patients with less significant clinical demands may represent those who are relatively easier to manage and undergo a less stormy recovery in the immediate ICU postoperative period than those with higher demands. These less demanding patients, with lower risk prediction scores, may require less ICU intervention than their more complex counterparts, and thus have an expedited return to the ward resulting in a shorter ICU LOS. Conversely, those with higher demands, emergency patients, higher risk prediction scores and requiring longer ICU LOS represent a cohort ultimately less likely to survive. Does this, therefore, imply that the longer one requires ICU treatment the worse outcome one may expect, representing ICU LOS as a negative prognostic indicator? Certainly, in other studies, increased ICU LOS was associated with higher APACHE II score and emergency admission, both being independent predictors for increased ICU LOS.⁹ Interestingly, in those who were admitted to the ICU for > 21 days, APACHE II score was observed to plateau.⁹

When considering patients who survived a successful discharge from the hospital, and it was apparent that total hospital LOS was similar for both those admitted elective and as an emergency (18.57 days vs. 21.84 days, \(P\) not significant, mean 21.08). What this seems to suggest in combination with the above is that while the total hospital admission remains the same between elective and emergency patients, the location of their stay is proportionally different. It can be concluded that elective patients spend a shorter time in the ICU and longer on the general ward, whereas emergency patients spend longer on ICU and proportionally shorter time on the general ward. Does this, therefore, imply that the ICU admission expedites time to discharge for the emergency cohort, matching the elective counterparts? Would keeping the elective cases on ICU longer also expedite their hospital discharge and represent a reduction in the total hospital admission LOS? If so, would this be an economically viable idea to help free up bed space in the hospital and ease bed pressures and could this be reproduced in ward-based high care settings? More studies are needed.¹¹
CONCLUSION

Patients who did not survive had longer ICU LOS and raises an interesting debate about decisions regarding withdrawal of treatment. It may; however, reflect something that is widely accepted—those who are unwell, with higher risk prediction scores, have higher demands and longer treatment requirements. Such patients inherently are at higher risk of not surviving and therefore skew the data. Appropriate patient selection to the ICU is a challenging and difficult decision and is not a decision to be taken lightly. There is no doubt that intensive care makes a difference to patient outcomes as longer ICU stay expedites hospital discharge and reduces overall hospital stay among emergency patients. The idea that a similar observation might be seen among elective patients is an interesting concept that was not addressed in this study but may warrant further investigation.

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Conflicts of interest
There are no conflicts of interest.

Research quality and ethics statement
This study was deemed to be exempt from Institutional Review Board approval at St. Luke’s University Health Network. The authors followed applicable EQUATOR Network (http://www.equator-network.org/) guidelines during the conduct of this research project.

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