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ORIGINAL ARTICLE

# Surgical admissions to Intensive Therapy Unit at Mater Dei Hospital: a prospective 3 month study

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## Introduction

Patient care in an acute hospital is divided into 4 levels, with level 0 being least demanding and level 3 comprising intensive care. A surgical high dependency unit (HDU) offers level 2 (intermediate) care and is indispensable when escalating or de-escalating from lower or higher levels of care respectively. Mater Dei Hospital lacks such a dedicated unit.

## Methods

Data was prospectively collected over a 3-month period and included all surgical patients admitted to the intensive therapy unit (ITU), including subspecialties. The duration and reasons for admission to hospital and ITU were documented. Hospital admissions were either planned or emergency. Reasons for ITU admission were either planned or unplanned after elective surgery, following emergency surgery, directly from the Emergency Department or following clinical deterioration in a level 0 ward. Number of organs supported, any surgical interventions during admission and the final outcome were noted.

## Results

There were 173 surgical patients admitted to ITU (116 males) with mean age 61.2 years. Most were post-surgery (71.7%, *n*=124) or after being stabilised at the Emergency Department (21.4%, *n*=37). Fewer required escalation from normal ward-based care (6.94%, *n*=12). Transfers from other hospitals occupied 3 ITU beds (1.73%). Mean ITU stay was 3.4 days per patient, with 6.5 beds being occupied by surgical cases on a daily basis. Forty-one percent of patients met the criteria for HDU.

## Conclusion

With an ever growing population, there is a need to set up a local surgical HDU. This will help relieve the recurrent shortage of ITU beds without compromising the level of healthcare delivered.

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## Introduction

In an acute general hospital catering for patients with varying complaints, the level of healthcare delivery is divided into four categories. Level 0 is the least demanding and includes normal ward-based care of otherwise stable, non-complex patients without the need of specially trained nursing staff. Level 1 care encompasses more demanding patients at risk of deterioration. This can be in the form of escalation from level 0, or de-escalation from a higher level of care. Although their needs can be met in a normal ward, additional critical care back-up is necessary. Level 2 is equivalent to a High Dependency Unit (HDU), with a nurse-to-patient ratio of 1:2. Patients falling in this category are those who have a single failing organ system, are admitted as a precautionary measure (such as post-major or complex surgery) or when de-escalating from higher levels of care. Level 3 is highly specialised care which is provided in an Intensive Therapy Unit (ITU). Patients often require advanced respiratory support (sedation and invasive ventilation) or less invasive airway support in the presence of at least two deteriorating organ systems. Any patient with multi-organ failure also falls in this category.[1-2]

Out of approximately 1000 beds in our main acute hospital, 20 are assigned to a combined HDU/ITU without a dedicated surgical HDU (table 1 below shows the basic setup for manning a HDU).[3] As bed space is a recurring issue, sometimes it becomes difficult to provide care in the most appropriate environment. Health care cost is also an important factor, with ITU beds being the most expensive to run. The objective of this audit was to define the load on our ITU from surgical admissions who could be cared for on a HDU. The main criteria assessed were mode of admission, number of organs requiring support, length of stay in ITU and in hospital, caring specialty and outcome after hospital stay.

## Methods

Data protection approval from Mater Dei Hospital was obtained before commencing the anonymous prospective data collection from patient's notes and daily progress charts. The first author recorded information on paper which was later transferred to a dedicated spreadsheet created using Microsoft Excel 2007. This was kept in a password-protected database and updated regularly. Statistical analysis was carried out using the same software.

All surgical patients admitted to ITU between 1st February 2018 and 30th April 2018 (3 months) were included. Non-surgical patients including those falling under obstetrics and gynaecology were excluded. Demographic details such as age, gender, comorbidities and American Society of Anaesthesiologists (ASA) score were recorded. The duration and reasons for admission to hospital and ITU were documented. Mode of admission to hospital was classified into either emergency or elective. Reasons for ITU admission were categorised into: planned admission after elective surgery, unplanned admission after elective surgery, as an emergency directly from the Emergency Department, after emergency surgery or following deterioration in the ward. Proper justification for escalating to level 3 and the primary caring specialty were also documented. Patients were followed-up until the end of their stay in hospital and the final outcome was recorded. Particular attention was given to the number of organs supported, name of surgical procedures performed and any complications suffered.

**Table 1** Basic HDU requirements. A HDU has to be geographically linked with the ITU and resources for resuscitation of the critically ill must be immediately available.[3]

| | |
|---|---|
| **Medical staff** | A medical/surgical trainee with appropriate training and experience available 24-hours a day. |
| | An attending Intensive Care Specialist who is also responsible for admissions to the HDU. |
| | Designated Medical Director trained in Intensive Care medicine. |
| **Nursing staff** | Nurse-to-patient ratio of 1:2.<br>The majority of senior nurses should be qualified in intensive care or high dependency care nursing.<br>HDU Charge Nurse should have a degree in Intensive Care medicine. |
| **Services** | Seamless access to ITU, opecrating theatres, radiology, pharmacy and pathology laboratories. |
| | Regular input from physiotherapists and other health care professionals (including occupational therapy, dietician, tissue viability services, etc). |
| | Technical and clerical staff. |
| **Operational** | Guidelines on admission, management and discharge of patients. |
| | Formal auditing procedures and policies to implement changes. |
| | Infection control/isolation protocols (including designated cubicles). |
| | Access to facilities for continuous professional development. |
| | Formal introductory program for new recruits. |

## RESULTS

Out of a total of 173 patients admitted to ITU, 67.1% (*n*=116) were males and 32.9% (*n*=57) were females. Mean age was 61.2 (range 2-90) years. Elective hospital admissions that were later transferred to ITU amounted to 82 patients while 91 were emergency admissions. Most patients were taken to intensive care following surgery (71.7%, *n*=124) or after being stabilised at the Emergency Department (21.4%, *n*=37). Fewer required escalation from normal ward-based care (6.94%, *n*=12). Transfers from other hospitals occupied 3 ITU beds (1.73%).

## Modes of admission to ITU

- **Transfers to ITU following elective hospital admission**

The majority of elective hospital admissions that later required ITU had a pre-booked level 3 bed and followed elective surgery (86.6%, *n*=71). Five patients (6%) had an unplanned ITU admission after elective surgery. One involved deviation from the original surgical approach (laparoscopy converted to open subtotal colectomy), 2 experienced intra-operative hypoxic events and 2 had cardiovascular instability (1 being hypotension secondary to haemorrhage). Two of these patients later passed away. Four patients (5%) underwent emergency surgery for complications acquired during elective procedures (such as bowel perforation at colonoscopy) or unrelated to previous surgery (laparotomy for faecal impaction and perforation). A minority (1.16%, *n*=2) suffered deterioration in the ward from other causes and required escalation of care.

- **Transfers to ITU following emergency hospital admission**

A significant number of emergency admissions were taken directly from the Emergency Department to intensive care (40.6%, *n*=37) or underwent emergency surgery prior to ITU transfer (39.6%, *n*=36). Four patients (4.4%) were taken to ITU after semi-elective interventions (2 vascular and 2 neurosurgical patients). Four others were unplanned admissions after encountering problems during femoral fracture fixation, semi-elective femoral hemiarthroplasty, laparoscopic cholecystectomy and one case of diverticulitis that became complicated by abscess formation and sepsis requiring Hartmann's procedure one month into the admission. A proportion of emergency hospital admissions that were initially cared for in a level 0 setting required escalation to level 3 at some point during their stay (5.78%, *n*=10). Figure 1 summarises the nature of emergency admissions to hospital requiring ITU.

## Length of stay

The cumulative number of ITU days occupied by surgical patients was 589, or 6.5 beds per day with a mean ITU stay of 3.4 days (table 2 and figure 2).

## Organ support

The organ systems requiring physiological support were divided into brain/central nervous system, renal, cardiovascular, respiratory, metabolic and immune system (figure 3). The number of organs supported per patient is displayed in figure 4. Of those with single organ support (*n*=75), the cardiovascular system was addressed in 42 patients, while 14 required neurological support namely neurocharting after neurosurgical intervention, intracranial pressure monitoring and monitoring after severe head injury. Fourteen patients received respiratory assistance. Renal function was supported in 5 other patients in the form of haemodialysis for metabolic derangement, support after renal transplant and management post-nephrectomy.

ASA scores are shown in table 3. There is a general trend towards more organs requiring assistance in subjects admitted as an emergency and in patients with a higher ASA score (figure 5).

**Figure 1** Breakdown (patient numbers) of emergency admissions to hospital requiring immediate transfer to ITU. Mortality in this group was 46% (17 patients). They mainly suffered polytrauma (30%) after motor vehicle accidents or falls from height. There was one case of non-traumatic splenic rupture resulting from malignant infiltration.

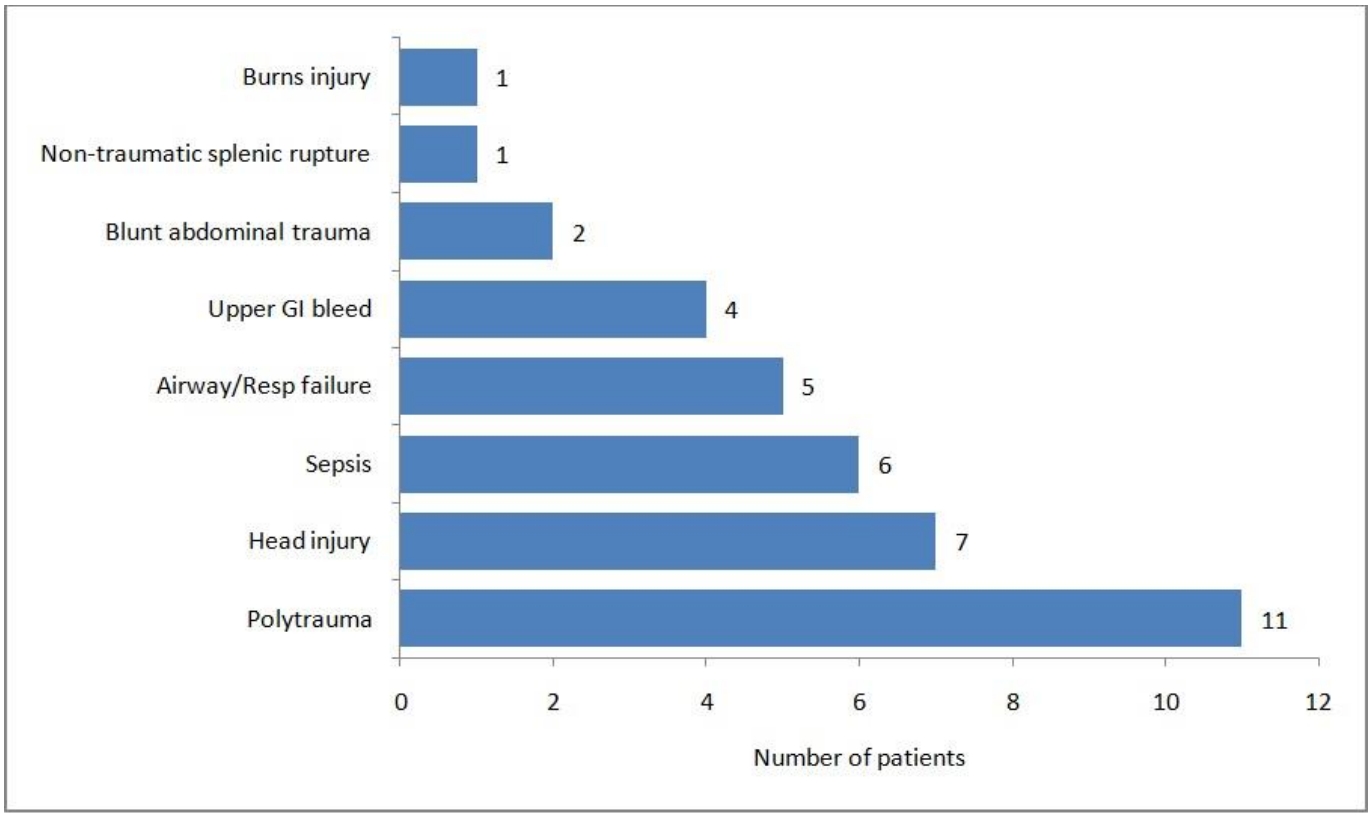



**Table 2** Admission days by specialty.

| | Cumulative days spent in ITU (range, mean) | Cumulative days spent in hospital (range, mean) | Number of patients (*n*) |
|---|---|---|---|
| **General surgery** | 133 (1-9, 2.66) | 877 (1-68, 17.5) | 50 |
| **Vascular surgery** | 50 (0-11, 1.43) | 560 (2-60, 16.0) | 35 |
| **Neurosurgery** | 120 (1-16, 4.62) | 558 (1-74, 21.5) | 26 |
| **Orthopaedics and trauma** | 79 (0-24, 3.76) | 444 (1-68, 21.1) | 21 |
| **Upper gastrointestinal surgery** | 90 (1-62, 6.92) | 245 (2-69, 18.8) | 13 |
| **Urology** | 45 (0-26, 4.09) | 195 (4-54, 17.7) | 11 |
| **ENT** | 27 (1-8, 4.5) | 275 (8-147, 45.8) | 6 |
| **Transplant surgery** | 17 (2-5, 3.4) | 174 (9-104, 34.8) | 5 |
| **Endocrine surgery** | 8 (1-5, 2.67) | 22 (5-10, 7.33) | 3 |
| **Paediatric surgery** | 4 (2*) | 40 (9-31, 20) | 2 |
| **Plastic surgery** | 16 | 23 | 1 |
| **Total :** | 589 | 3434 | 173 |

**Figure 2** Types of organs supported in the cohort of patients. Note that a particular patient may have more than one organ needing support.

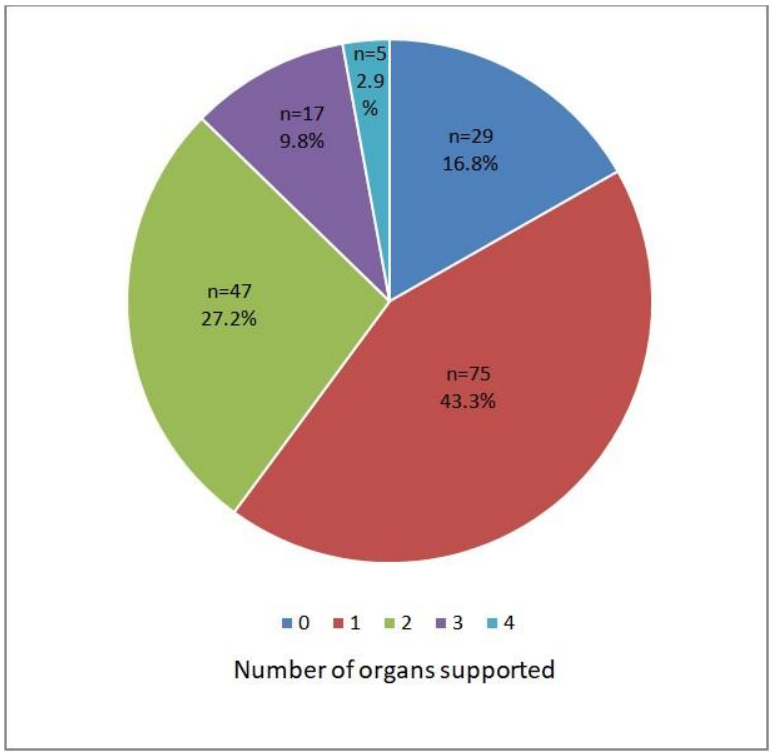



**Figure 3** Number of organs supported per patient. Most required none or single organ support. No organ support often implied a short post-operative precautionary ITU stay as normal ward-based care was deemed unsafe in the immediate post-operative period should the patient deteriorate.

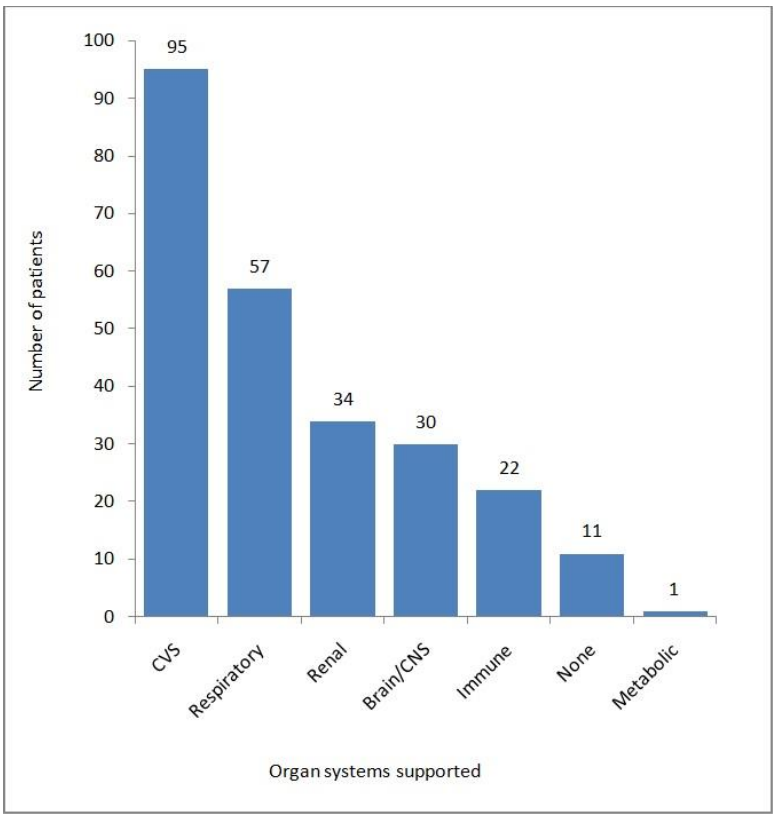


**Figure 4** Mean number of organs supported in relation to ASA score. As a general rule, with worsening physiology, patients become increasingly demanding as more organs need attention.

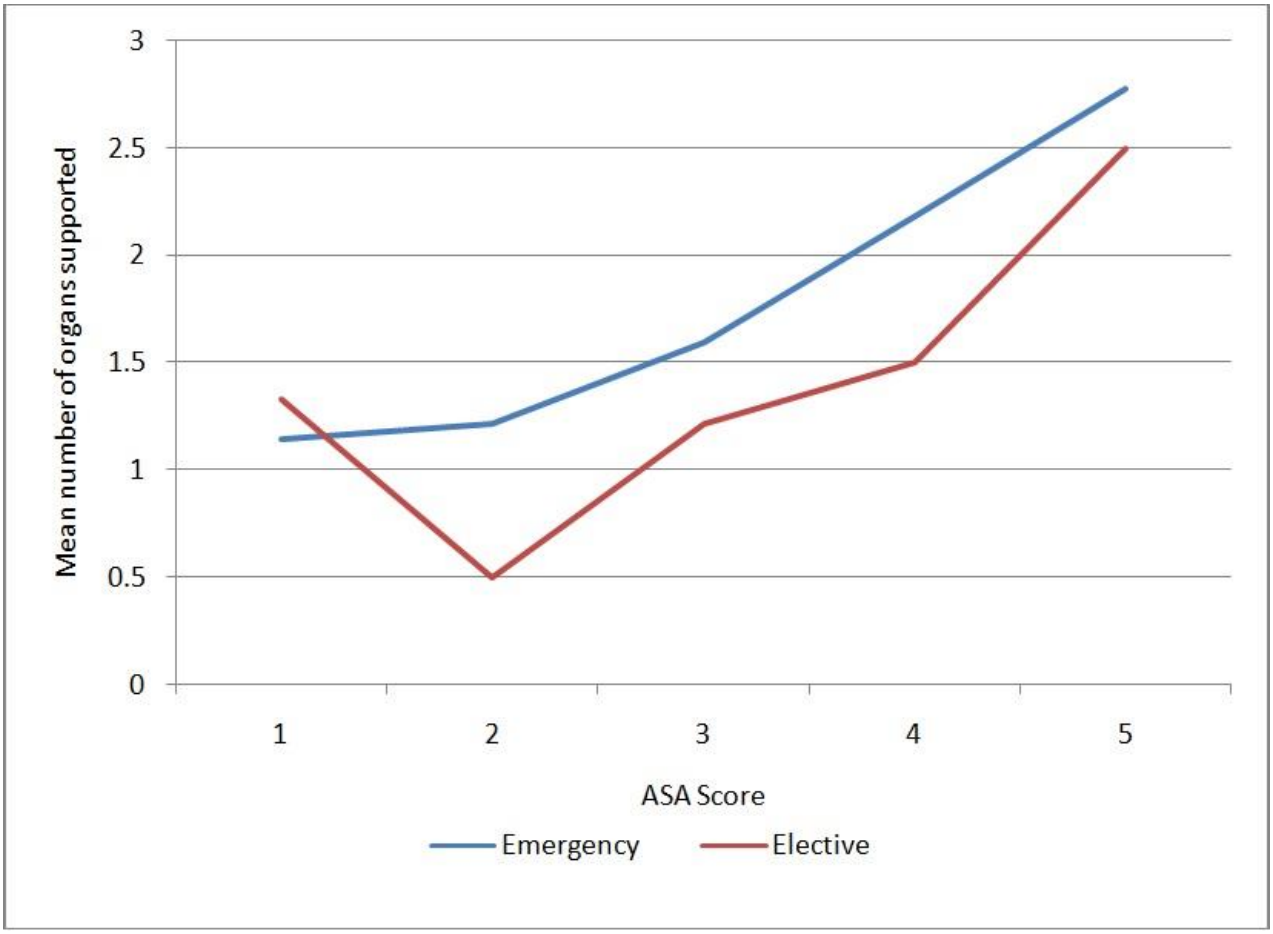
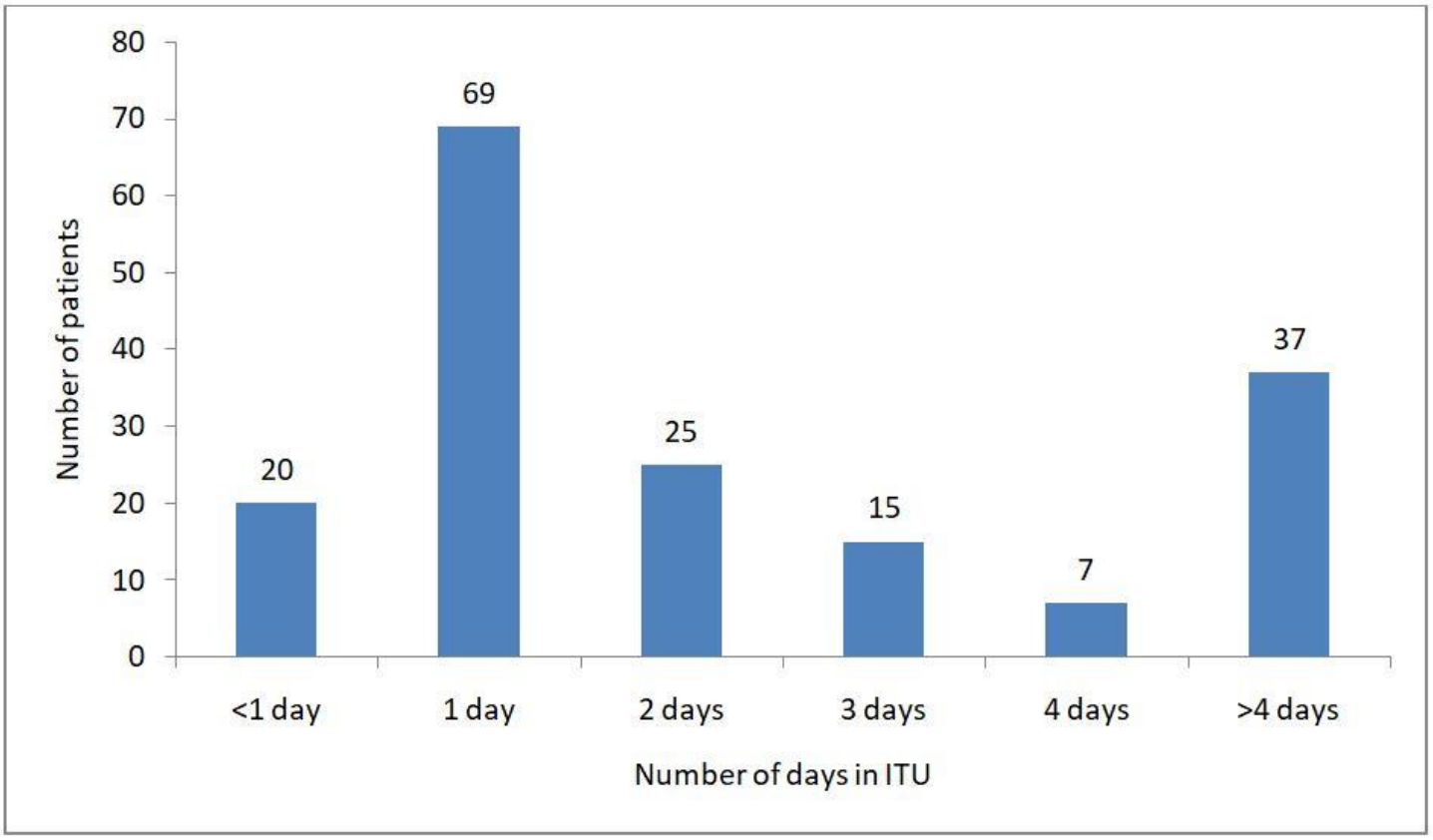



**Table 3** ASA scores in relation to admission type. For the column displaying percentage patients, the total number of participants (*n*=173) was used as the denominator.

| ASA Score | Mode of admission | Number of patients (*n*) | Percentage patients | Mean number of organs supported |
|---|---|---|---|---|
| 1 | Emergency | 14 | 8.09% | 1.14 |
| | Elective | 3 | 1.73% | 1.33 |
| 2 | Emergency | 14 | 8.09% | 1.21 |
| | Elective | 30 | 17.3% | 0.50 |
| 3 | Emergency | 32 | 18.5% | 1.59 |
| | Elective | 41 | 23.7% | 1.22 |
| 4 | Emergency | 22 | 12.7% | 2.18 |
| | Elective | 6 | 3.47% | 1.50 |
| 5 | Emergency | 9 | 5.20% | 2.78 |
| | Elective | 2 | 1.16 | 2.50 |

**Figure 5** Distribution of patients according to days spent in ITU.




### Patient outcomes

Mortality was recorded in 19.7% (*n*=34) of patients and this rose exponentially as the number of organ failures increased. Indeed, seven 7 had a single deteriorating organ function while 27 deceased patients had two or more organ failures. No deaths were reported in the cohort that required monitoring post-operatively without invasive organ support. A significant proportion were discharged home after completing their hospital stay (71.7%, *n*=124). Nine were transferred to a non-acute hospital and 6 flown to other centres overseas.

## Discussion

The National Confidential Enquiry into Peri-Operative Deaths recommends that high-risk surgery should be avoided unless facilities for post-operative care are available and proposes a list of measures aimed at reducing post-operative mortality. This led to the concept of surgical HDUs in some institutions which offer intermediate care between ITU and the general wards.[4-5] Such unit was introduced by the Department of Anaesthesia and Intensive Care at St Luke's Hospital as an annex to the ITU. Upon migration to Mater Dei Hospital, this became a single ITU/HDU. Presently the Cardiac Intensive Care Unit also admits elective post-operative vascular surgical patients to offload the demand from the main ITU/HDU. Nevertheless, there is a need for a dedicated surgical HDU at Mater Dei Hospital as can be seen by this prospective study.

Our results showed that 71 (41%) ITU surgical patients received no organ support or cardiovascular support alone. These spent a combined total of 97 days in intensive care, making up 16.5% of total surgical ITU bed days

over the 3-month period of data collection. These numbers are significant, implying that a large proportion of patients admitted to a level 3 ward could have been safely managed in a level 2 environment. Literature also states that up to one-third (21-40%) of ITU beds may be occupied by high-dependency patients at any point. Conversely, a proportion of patients requiring HDU care may be inappropriately managed in a level 0 ward.[6]

Setting up a surgical HDU is not an easy feat. Apart from allocating physical space, it involves purchasing modern equipment, regular training of specialised staff, development of guidelines and protocols (including admission and discharge criteria based on risk assessment – table 3), and liaison between departments such as pharmacy, medical stores, sterile services and information technology among others. Healthcare professionals such as physiotherapists, dieticians and outreach teams must be accessible and there should be 24-hour surgical consultant availability. Since HDUs are typically manned by surgical teams (including on-call trainees outside regular hours) and not led by anaesthetists, proper backup plans must be in place in case of patient deterioration with the requirement of invasive respiratory support. Therefore, close proximity to the ITU is a plus.[5,7]

HDU care incorporates three basic principles: fluid and electrolyte balance, analgesia and proper oxygenation. It also offers the possibility of continuous cardiovascular monitoring and in some instances, inotropic cardiovascular support. Not every patient is a candidate for HDU, but those benefitting from it are often the ones at risk of renal and cardiac impairment, especially the elderly and emergency surgical cases (Table 4). Close attention to fluid balance with immediate correction reduces the incidence of these complications. In the study by Jones et al comparing post-operative outcomes of general surgical patients after HDU care vs no-HDU, the former resulted in significantly less hypotensive episodes, arrhythmias, wound and chest infections. Hospital stay was also less but did not reach statistical significance.[6] A study by Solberg et al from the Netherlands showed no difference in mortality rates with the introduction of HDU but there was better utilisation of intensive care facilities.[8]

**Table 4** Example of criteria for selecting patients who might benefit from HDU care.[4]

| |
|---|
| Need of support for a single failing organ excluding requirement of advanced respiratory or renal support. |
| Patients undergoing major, complex surgery requiring close post-operative observation who would benefit from more detailed monitoring than can safely be provided on the ward, including patients requiring complicated fluid management and frequent drug intervention. |
| Patients who no longer need intensive care but are not fit enough for the general ward. |
| Post-operative patients who need close monitoring for more than a few hours expectedly or otherwise. |

In a study evaluating satisfaction and quality of care, nurses felt that level 0 healthcare delivery improved after the opening of a HDU because the removal of more demanding patients enabled them to dedicate more time to their less acute cohort. On a similar note, nurses working in the HDU felt they could provide better holistic patient care which in

turn translated in a high job satisfaction. These findings also reflect patient satisfaction which is heavily dependent on carer availability, attitude and empathic approach rather than expertise alone. Furthermore, time to analgesic administration was superior in the HDU.[9]

One must also appreciate the educational potential of HDUs for surgical trainees, which parallels the teaching aims of our main acute general hospital. The Royal Surgical Colleges give particular importance to critical care and the subject regularly features in examinations and related courses. Apart from having formal rotations within the unit during surgical training, feedback from experienced surgical teams and nursing staff in such a demanding environment helps the trainee to build a comprehensive educational and practical portfolio. Exposure to several complex cases which are followed closely on a day-to-day basis allows the best possible continuity of care and therefore better understanding of the disease and recovery process. Communication with patients and relatives makes trainees better at breaking bad news and builds their confidence when discussing treatment plans with medical and non-medical individuals.[10]

Limitations of this study include its non-controlled nature. Missing data due to unobtainable records of deceased patients prevented the authors from compiling a full list of physiological scores and nursing time allocation as was originally planned. Re-admissions were considered as separate entries in the data collection. Seasonal variation might influence ITU admissions and no record was kept on those patients who were refused ITU admission or had their elective surgery postponed due to bed shortage. Furthermore, there was no record of vascular patients admitted to cardiac intensive care unit or patients requiring level 2 care but not referred to ITU.

## Conclusion

This study confirms the general impression that many patients currently admitted in our ITU/HDU could be treated in a level 2 surgical facility (surgical HDU). Although one might argue that HDU is costly to set up, it then becomes more cost-effective over time. HDU can be a standalone unit or even an extension of an existing ward, but the latter is difficult to implement because staff needs to be highly trained and constantly updated with regards to modern techniques and equipment. Allocating personnel to man such ward-based HDUs also implies depriving the less dependent patients from nursing care, as staff will instinctively dedicate more of their time caring for the sicker cohort.[6] Therefore, the best way to treat those patients who are not fit for a normal ward but do not have the criteria for intensive care is to admit them to a separate surgical HDU. This will help relieve the shortage of ITU bed space without compromising the level of healthcare delivered and potentially eliminates problems such as premature discharge from intensive care or delaying elective major surgery.[4,5] Similarly, some of the elective post-operative patients in this study could have been admitted to a Post-Anaesthesia Care Unit (PACU).

Although a larger, prospective, hospital-wide study would be required to define the total population that could benefit from a surgical HDU, the authors believe that such a unit would improve patient safety and support the current overstretched level 2/3 facility. This offsets the additional running costs. From a surgical department point of view, this would require additional training in Intensive Care for surgical trainees and resident specialists

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