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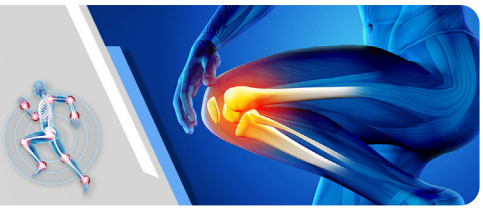

A Service Evaluation Examining the Requirement for Level 2 Critical Care in a Major Trauma Centre

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Keywords: Critical care; High-dependency; HDU; Perioperative care; Resource allocation

Summary

Critical care provision is fundamental in all developed health systems in which severe disease and injury is managed. This is especially true in major trauma centres and high-acuity establishments, where acutely unstable patients can be admitted at any time, requiring clinical monitoring and interventions appropriate for their burden of illness. This single-centre, prospective service evaluation applied validated scoring systems to a surgical population, sampling and following those considered "high-risk" through to discharge or death, alongside all Intensive Care Unit (ICU) admissions during 2019. Primarily we aimed to quantify the number of patients objectively suitable for Level 2 critical care, conventionally provided in a High-Dependency Unit (HDU) setting. Secondary outcome measures included ICU readmission rate, in-hospital mortality, and delays to ICU admission and discharge. Of the "high-risk" surgical patients, more than eight per week were found to have perioperative Portsmouth Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity (P-POSSUM) scores that would advocate critical care admission. Only one individual received scheduled peri-operative critical care. Post-operative mortality in this group was 6.1%, though none of these patients was admitted to ICU prior to death. There were 605 ICU admissions in 2019, with 32.1% of admitted days spent at the equivalent of Level 2 critical care, which could have been administered in a HDU if one was available. The ICU readmission rate was 6.45%. This data demonstrates substantial unmet critical care needs, with patients not uncommonly managed in clinically inappropriate areas for extended periods due to delays accessing ICU. A designated HDU may mitigate clinical risk from this subgroup, reducing morbidity and in-hospital mortality, and this methodology for assessing requirements could be used in other similar institutions.

Introduction

Critical care is a vital component of any acute hospital system and the safe, effective, and timely management of critically ill patients should be a priority. It encompasses supportive care and interventions aimed at preservation in life-threatening conditions, with the ultimate goal being the restoration of pre-morbid status [1].

Whilst both High-Dependency Units (HDUs) and Intensive Care Units (ICUs) provide iterations of critical care, the distinction between Level 2 care provided in a HDU and Level 3 care provided in an ICU are both clinical and logistical [2]. Those requiring single-organ support excluding invasive mechanical ventilation will generally be cared for in a HDU typically with a 2:1 patient-nurse ratio. ICUs are reserved for those with multi-organ

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involvement and require a 1:1 patient-nurse ratio. For completeness, Level 1 care refers to a ward-level bed with the availability of continuous monitoring, and Level 0 care corresponds to a bed at general inpatient level [3].

A deteriorating patient can be admitted to HDU to prevent further decline and reduce the need for ICU [4], termed "step-up care". Conversely, patients may transition through HDU on their pathway out of critical care in a "step-down" approach. The discharge process has the potential to be hazardous, but HDU can provide a safer transfer, limiting the need for readmission to ICU as well as reducing incidence of adverse events [5].

Critical care beds are a scarce resource in Ireland, with only five beds per 100 000 population according to the latest report in April 2020 [6]; amongst the lowest in the developed world. The imbalance in this supply and demand ratio has been further underscored by the SARS-CoV-2 pandemic [7]. As baseline provision of critical care is so stretched, it is vital that these beds are utilised optimally going forward. The presence and appropriate utilisation of HDUs within Irish hospitals may alleviate ICU burden and optimise bed availability for those who need them most. There is evidence that patients are admitted to Level 3 critical care beds in Ireland without meeting generally-accepted criteria for ICU admission [8]. Conversely, a shortage of critical care beds and staff have necessitated the management of critical care patients outside of appropriate settings. It is clear that this practice of placing critically unwell patients in inappropriate clinical areas poses a major risk for poorer outcomes in this population [9-11].

Cork University Hospital (CUH) is an example of an acute setting in which recommendations in critical care are not currently being met [8]. It is a regional centre for both secondary and tertiary care for approximately 550 000 people in the wider County Cork area, and a supra-regional referral centre for a population of over one million across five additional counties, constituting around 25% of the Irish population [12]. Despite the accolade of being a "Level 1" trauma centre, CUH does not presently have a designated medical or surgical HDU. It has capacity for up to fourteen patients in its general ICU, with ten further cardiac ICU beds, which are ring-fenced for cardiothoracic surgery.

Locally, the Irish National ICU Audit (INICUA) suggests that critically ill patients are being discharged directly from ICU to general wards with alarmingly high National Early Warning Scores (NEWS), indicating a pressure on ICU beds that is managed without the facility of step-down areas [13]. Furthermore, Irish ICUs typically suffer delays to admissions and discharges due to a scarcity of appropriate beds, both within and outside of critical care. Currently there are significant logistical barriers to identifying patients who meet clinical criteria for critical care but cannot be admitted due to limitations on beds, constituting an unquantifiable unmet need in the Irish critical care system [14].

This single-centre observation service evaluation was conducted to facilitate further discussion and quality improvement regarding the scale of potential unmet patient needs in Ireland's only major trauma centre. Primarily, we intended to quantify the number of patients meeting criteria for Level 2 critical care each week, from both medical and surgical populations. Secondary objectives included quantifying the number of patients managed in clinically inappropriate settings, whether this is Level 2 patients being admitted to ICU, or, conversely, Level 3 patients being managed for prolonged periods in general wards, the Post-Anaesthesia Care Unit (PACU), or the resuscitation bays of the Emergency Department (ED). Further secondary objectives included calculation of the ICU readmission rate, in-hospital mortality, and rates of delayed admission or discharge from ICU. Is it possible that a decade on from the original report, there remains sufficient unmet need within CUH for the provision of HDU care?

Methods

No ethical approval was required, but permission to access and collect anonymised patient data was granted at local level. This service evaluation had a primarily quantitative focus, and was conducted as a single-centre, prospective observation study in CUH, a trauma centre located in Cork, Republic of Ireland. Patients were included if they were aged 18 years or older and excluded if they were undergoing cardiothoracic or obstetric surgeries as their primary admission reason, unless subsequently admitted to the adult general intensive care unit.

Surgical cohort

Over an eight-week period between October and December 2019, we collected data on patients undergoing elective, urgent, and emergency non-cardiac, non-obstetric surgery graded as either 'moderate', 'major', or 'major plus' [15]. The Portsmouth Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity (P-POSSUM) was adapted to capture this surgical population and calculated to estimate each individuals' risk of post-operative morbidity and mortality [15,16], with data taken from intraoperative records, laboratory results, ECGs, and clinical documentation. We also documented New York Heart Association (NYHA) scores and clinical frailty scores for these patients [17,18]. These patients were followed through to discharge or death, tracking any unplanned changes in level of care. See Table 1 for a summary of parameters collected and scores utilised. A subgroup of patients with P-POSSUM Mortality scores of 10% or higher was created as potential candidates for critical care admission, similar to the metric used by the National Emergency Laparotomy Audit (NELA) Group [19].

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ICU cohort

Across 2019, electronic data was collected via the Intellispace Critical Care Anaesthesia (ICCA) information system auditing office at CUH on all critical care admissions, regardless of disease process. Prognostic scoring systems are automatically calculated by ICCA, whereas other clinical information was drawn from admission and discharge documentation, as well as electronic nursing records. See Table 2 for a summary of parameters collected and scores utilised, including the Acute Physiology and Chronic Health Evaluation score (APACHE-II), Sequential Organ Failure Assessment score (SOFA), Intensive Care National Audit and Research Centre score (ICNARC), and National Early Warning Score (NEWS) [20-22]. Collected data for both groups was entered into spreadsheets and quantitative data analysis was undertaken separately for each cohort.

Results

This service evaluation set out to examine the quantitative demand for Level 2 critical care in a designated trauma centre without the facility of a HDU. Prospective observation of high-risk surgical patients and ICU admissions took place over eight weeks and one full calendar year respectively.

Surgical cohort

As summarised in Table 3, 159 high-risk surgical patients were observed during the eight-week data collection period, an equivalent of 19.9 adults per week undergoing 'moderate', 'major', or 'major plus' surgery outside of cardiac and obstetric specialties. Potential HDU candidates, those with P-POSSUM Mortality scores ≥10%, made up 41.5% of this sample; equating to 8.25 patients per week. Median length of stay for the entire surgical cohort was eight days (9.5 IQR [4.5 – 14.0]), whereas for the HDU candidates, the median length of stay was 12 days, (14.75 IQR [6.25 – 21.0]).

11 patients from the 159-person sample were admitted to ICU at some point post-operatively, with seven being unplanned. 81 patients remained in PACU for more than two hours, followed by general ward admission. Of the 107 patients with a New York Heart Association (NYHA) class of II or more, 46 were discharged from PACU to a general ward

Table 1: Data parameters collected for surgical cohort patients, with appropriate ranges or units expressed for clinical scores.

Serological data	Patient observations	Clinical scores	Surgery-specific data	Other
Haemoglobin (g.l-1)	Heart rate (beats per minute)	P-POSSUM [15,16] (morbidity and mortality; %)	Estimated blood loss (ml)	Hospital length of stay (days)
White blood cell count (10^9.l^{-1})	Systolic blood pressure (mmHg)	NYHA classification [17] (I-IV)	Intraoperative blood transfusion (Y/N)	Malignancy (Y/N)
Urea (mmol.l^{-1})	Glasgow Coma Scale (3-15)	Clinical Frailty Score [18] (1-9)	Peritoneal contamination (Y/N)	Procedure number (1-3)
Creatinine (μmol.l^{-1})	ECG findings (normal sinus / atrial fibrillation 60 – 90 beats per minute / other abnormailty)		Grade of surgery (moderate / major / major plus)	Use of arterial line (Y/N)
Sodium (mmol.l^{-1})	BMI (kg.m^{-2})		Urgency (elective / urgent / emergency)	Destination prior to discharge or death (ICU / PACU [< or >120 minutes] / ward)
Potassium (mmol.l-1)			Theatre time (hours)	

P-POSSUM: Portsmouth Physiological and Operative Severity Score for enUmeration of Mortality and morbidity; NYHA: New York Heart Association; Y: Yes; N: No; PACU: Post-Anaesthesia Care Unit

Table 2: Data parameters collected for ICU cohort patients, with appropriate ranges and units.

Temporal data	Admission data	Clinical scores	Care data	Discharge data
Timeliness of admission (<60 minutes / delayed)	Readmissions (0 - 1)	NEWS [20] (0 - 20)	CPR prior to admission (Y/N)	Status at discharge from ICU (alive / deceased)
Delay to admission [if applicable] (<60 minutes / 60 – 120 minutes / > 120 minutes	Location prior to ICU	APACHE II [21]	Highest level of care in first 24 hours	Status at discharge from hospital
	(ED / OT / ward / other ICU / other hospital)	(0 - 71)	(1 / 2 / 3)	(alive / deceased)
Timeliness of discharge (early / ready / delayed)		SOFA [21] (0 - 24)	Treatment withheld or withdrawn (WH / WD / both)	
		ICNARC [22] (0 - 100)	Time at each given level of care (days)	

ED: Emergency Department; OT: Operating Theatre; NEWS: National Early Warning Score; APACHE II: Acute Physiology and Chronic Health Evaluation; SOFA: Sequential Organ Failure Assessment; ICNARC: Intensive Care National Audit and Research Centre; Y: Yes; N: No; WH: Withheld Care; WD: Withdrawn Care [20-22]

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after less than two hours post-operatively. Of the subgroup with P-POSSUM Mortality scores ≥10%, eight received ICU care, with just one of these admitted electively.

Post-operative in-hospital deaths were observed in five of the 159 surgical patients, with four deaths occurring within 14 days of surgery. In this group, the median P-POSSUM Mortality score was 22.8% (12.3 IQR [13.2 – 25.5]), and the median P-POSSUM Morbidity score was 76.9% (37.7 IQR [51.9 – 89.6]). Four of the HDU candidate subgroup (mortality risk ≥10%) died during their admission post-operatively, all having been monitored in PACU for more than two hours before returning to general ward care. None of the four were admitted to ICU at any point.

Table 3: Breakdown data for patients undergoing moderate grade surgery or higher of any urgency in an eight-week period including demographics, surgical parameters, and post-operative destinations, with subgroup data for patients with P-POSSUM mortality ≥10%. Age values are mean (SD); all others are n(%).

	Surgical cohort n=159	P-POSSUM Mortality ≥10% n=66
Patient characteristics		
Age	67.6 (14.9)	75.4 (10.4)
Males: Females	86 (54): 73(46)	40(60.6): 26(39.4)
Surgical characteristics	n (%)	n (%)
Urgency		
Elective	73 (46.2)	18 (27.3)
Urgent	79 (49.4)	41 (62.1)
Emergency	7 (4.4)	7 (10.6)
Grade		
Moderate	11 (7)	4 (6)
Major	121 (76)	50 (76)
Major plus	27 (17)	12 (18)
Specialty		
Orthopaedic	51 (32.1)	27 (41)
Neurosurgery	25 (15.7)	7 (10.6)
Vascular	14 (8.8)	7 (10.6)
General	47 (29.6)	22 (33.3)
Plastics/Breast	3 (1.9)	0 (0)
Urology	19 (11.9)	3 (4.5)
Post-operative care		
PACU > 120 minutes	82 (51.6)	33 (50)
No ICU	148 (93.1)	58 (87.9)
Scheduled ICU	4 (2.5)	1 (1.52)
Unscheduled ICU	7 (4.4)	7 (10.6)
In-hospital mortality	5 (3.14)	4 (6.1)

P-POSSUM: Portsmouth Physiological and Operative Severity Score for enUmeration of Mortality and morbidity; PACU: Post-Anaesthesia Care Unit.

ICU cohort

From January 1st to December 31st 2019, there were 605 admissions to the ICU, averaging 11.6 per week (Table 4 and 5). A total of 300 patients experienced a delay in ICU admission of greater than one hour from the time of the decision to admit, with a mean of 5.77 per week. Delays cumulatively totalled 604 hours, with a median delay of two hours (3 IQR [1-4]). Those with delays of more than two hours (122 patients; 20.2%), predominantly originated in the ED (n=77; 63.1%). A total of 215 patients were admitted to ICU from ED (35.5%), 127 from general wards (21%), and 159 were admitted from operating theatres (26.3%). The remaining ICU admissions in 2019 came from a wide range of locations including inter-hospital transfers, radiology suites, interventional cardiology services, endoscopy rooms, and PACU after adverse post-operative course (n=104; 17.2%). Thirty-nine (6.45%) of patients underwent ICU readmission during their hospital stay, and of these, 27 (69.2%) came from a general ward. Others were readmitted from other ICUs within the hospital, or from operating theatres.

A total of 72 patients (11.9%) received CPR prior to ICU admission, with an equal number occurring in-hospital and in the community. Of those who received in-hospital CPR, 15 patients (41.7%) received this on a general ward, and 27.8% (10 patients) were resuscitated in the ED.

In terms of levels of critical care administered, 461 patients (76.2% of the ICU cohort) received Level 3 care in the first 24 hours, and 23.8% (144 patients) received Level 2 care only in their first 24 hours of admission to ICU. This represents 8.87 and 2.77 patients per week respectively. A total of 3036 days of Level 3 care were provided across the study year, mean 5.01 (7.24), versus 1434 Level 2 care days, mean 2.37 (3.28). Of the entire ICU cohort, 116 patients (19.2%), received no Level 3 care during their admission. There was a total of 122 deaths (20.2%), of which 42 (34.4%) experienced an admission delay of at least one hour. Of the 483 patients who survived ICU, 45 (9.32%) died later during their hospital admission.

Of the 483 patients discharged from ICU, 337 (69.8%) were delayed in their discharge by at least one day, representing 6.48 patients per week. 59 patients (12.2%) were still in receipt of Level 2 care at point of ICU discharge; 396 (82%) were receiving Level 1 care. The 25 patients (5.18%) receiving Level 3 care were transferred or repatriated to other ICUs in the country. The modal NEWS at discharge was 3, with a range of 1 – 11. All patients discharged within CUH were sent to Level 1 and Level 0 areas within the hospital.

Discussion

This prospective, single-centre service evaluation intended to investigate the scale of need for critical care at a tertiary hospital designated as a Level 1 trauma centre. There

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Table 4: Breakdown of ICU patient data from 2019 including demographics and circumstances surrounding ICU admission. Age data is mean (SD), all other values are n(%).

	ICU cohort n=605
Patient characteristics	
Age	61.1 (16.6)
Males: Females n(%) : n(%)	360 (59) : 245 (41)
ICU admission circumstances	
Location prior to ICU admission	
ED	215 (35.5)
Ward	127 (21)
OT	159 (26.3)
Other (other hospital, other ICU, PACU, CCU, radiology)	104 (17.2)
Timeliness of ICU admission	
< 60 minutes	427 (70.6)
>60 minutes (total)	178 (29.4)
> 120 minutes	122 (20.2)
CPR prior to ICU admission	
No CPR	533 (88)
Received CPR	72 (12)
Location of CPR prior to ICU	
ED	10 (13.9)
Ward	15 (20.8)
OT	2 (2.8)
Other (other hospital, other ICU, CCU, radiology, endoscopy)	9 (12.5)
Community	36 (50)
Level of care during ICU admission	
In first 24hrs of ICU admission	
Level 2	144 (23.8)
Level 3	461 (76.2)
Patient care days total (one year)	
Level 2	1434 (32.1)
Level 3	3036 (67.9)
ED, Emergency Department; OT, Operating Theatre; PACU, Post Anaesthesia Care Unit; CCU, Coronary Care Unit; CPR, Cardiopulmonary Resuscitation.	

were two datasets interrogated, between operating theatres and ICU admissions, and findings would suggest the presence of areas for improvement.

Of the 66 patients with a P-POSSUM Mortality score ≥10%, only one received scheduled critical care in ICU, and all unscheduled ICU admissions came from this high-risk subgroup. There were four in-hospital deaths in this group, representing a mortality rate of over 6%, of which none were admitted to a critical care area. While many of these patients may not have been deemed suitable for prolonged mechanical ventilation or Level 3 care (due to factors such as burden of disease and frailty), the relative paucity of critical care beds with higher nurse-patient ratios leaves health care providers little choice but to limit these patients to Level 1 or Level 0 care. In addition, half of this subgroup spent longer than two hours in PACU, which may have a detrimental impact on flow through PACU and the operating department, and indicates that patients are being managed for prolonged periods in unsuitable clinical areas in lieu of critical care or appropriately monitored beds.

To put this into context, a Europe-wide cohort study into mortality after surgery found a crude mortality rate of 4%, lamenting that this was much higher than expected based on previous research [23]. Furthermore, the Royal College of Surgeons of England suggest that any patient with a predicted mortality ≥5% should be considered 'high-risk',

Table 5: Breakdown of ICU discharge, readmission, and mortality data from 2019, including circumstances surrounding these events. All values for ICU cohort expressed as n(%).

	ICU cohort n=605
Discharge circumstances	
Discharged from ICU	483 (80)
Timeliness of discharge	
Early	9 (1.9)
Ready	137 (28.4)
Delayed	337 (69.7)
NEWS at discharge	
0-3	302 (62.5)
45081	152 (31.5)
45176	27 (5.6)
≥10	2 (0.4)
Readmission circumstances	
ICU readmission	36 (7.45)
Location prior to ICU readmission	
Ward	27 (75)
OT	4 (11)
Other ICU	5 (14)
ICU mortality	
Mortality	122 (20)
Location prior to admission: ICU deaths	
ED	50 (41)
Ward	30 (24.5)
OT	19 (15.5)
Other (other hospital, other ICU, CCU, radiology, endoscopy)	24 (19)
Timeliness of admission: ICU deaths	
< 60 minutes	80 (65.6)
> 60 minutes (total)	42 (34.4)
> 120 minutes	32 (26.2)
NEWS, National Early Warning Score; OT, Operating Theatre; ED, Emergency Department; CCU, Coronary Care Unit.	

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and therefore requires planned post-operative care overseen by senior staff with the ability to recognise deterioration and escalate accordingly without delay [24]. Indeed, the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) recommendations from 2011 suggest that it may have become an area of complacency that high-risk surgical patients fail to gain admission to critical care, despite the known fact that those who die deteriorate in the absence of critical care intervention [25].

To date, there has been only one randomised control trial examining outcomes after HDU admission. The InCare group compared high-dependency with ward-level care following emergency abdominal surgery. However, the trial was prematurely terminated due to lower than anticipated overall mortality and poor recruitment [26]. Prior to this, prospective interventional studies have found improvements in ICU bed availability with the introduction of integrated (within-ICU) HDUs, although those operated by critical care staff demonstrate an increase in referrals and nursing workload [27], which, in itself is an independent risk factor for poorer outcomes [28]. The literature, whilst sparse, is generally supportive of the need for HDU care within acute hospitals.

Within the ICU population, almost half (300 of 605; 49.6%) experienced a delay in admission, with 40.7% of these being at least two hours. Over half of delayed patients were admitted from the ED (104 of 178; 58.4%), equivalent to two patients per week. In one case, this delay was 17 hours. Of the 41 delayed admissions from general inpatient wards, more than one quarter (26.8%) were managed on the ward, in a Level 1 or Level 0 area, for at least three hours prior to ICU admission. If the resuscitation bays of an ED can be considered inappropriate locations for critically ill patients to remain for any prolonged period [8-10,29], then certainly a general ward is unsuitable. However, this cohort of delayed admissions only accounted for 34.4% of the deaths, potentially meaning that health care providers were able to prioritise the admissions of patients with greater clinical need.

The ability of a critical care facility to discharge patients safely to other clinical areas is often dependent on the wider hospital environment [30-32], and whilst confounders make determination of causality difficult, the ICU readmission rate is a reasonable surrogate marker for success in the post-critical care trajectory, as readmission to intensive care has been associated with poorer patient outcomes [33,34]. The ICU readmission rate in 2019 was 6.45%, with 69.2% readmitted from a general ward. In 2013, a large retrospective cohort study looking at ICU readmissions in the United States quoted a rate of 5.9% [35]. Whilst our readmission rate was not hugely dissimilar, could these readmissions have been prevented if they had been appropriately managed in a HDU via a "step-down" service? NELA demonstrates that as far back as 2012, admission to critical care was necessary for any major or major-plus surgery carried out on an immediate or urgent basis in view of the associated high mortality [36]. It is difficult to compare our results directly with these recommendations as we expanded our cohort to include elective, urgent, and emergency procedures, and were not limited to solely laparotomies or even abdominal surgeries. However, given the volume of complex subspecialty surgery undertaken in CUH, it is clear we are not escalating these patients to higher levels of care, potentially at the cost of patient safety.

Discharges from ICU were also commonly delayed; 69.7% of patients were subject to delayed discharge, which is likely to be largely due to a lack of appropriate isolation beds (i.e. patients with communicable or drug-resistant infections), or indeed lack of Level 1 beds on the ward for appropriate monitoring. A small number of patients were discharged from ICU earlier than was deemed clinically appropriate: in all circumstances this was to create bed space for another, more critically unwell individual. Unfortunately, it is difficult to quantify how many patients were moved from ICU to PACU to create additional critical care space without being formally discharged from intensive care, which for the authors is known practice when capacity is exceeded.

Another important finding from this evaluation was that, on average, more than one patient every month was admitted following cardio-pulmonary arrest and subsequent resuscitation on the general wards of CUH. The necessity for CPR on the wards means that patients are deteriorating to an extent that they are experiencing catastrophic events during admission. What should be kept in mind is that the number of in-hospital CPR admissions to ICU represents only those who survive the arrest; a number which is already known to be a minority [4]. An additional layer of critical care in the form of a HDU could possibly reduce the frequency of cardiac arrest calls to general wards, by allowing admission of acutely deteriorating patients prior to the need for immediate and lifesaving intervention [4,5,9,12,37].

This service evaluation has attempted to quantify the scale of Level 2 critical care needs in CUH, suggesting that between eight and ten patients per week have needs that are currently unmet by virtue of a lack of any clinical areas equipped or staffed to accept such patients. Furthermore, it has identified instances in which patients have been managed in clinically inappropriate areas based on their medical need. Adverse outcomes, including death, have been demonstrated in both patient populations observed, which may have been avoided by adherence to global standards in critical care provision and planning.

However, the study has some limitations. The short period of surgical sampling (eight weeks) may have skewed the findings; the weeks sampled may have represented a period of unusual surgical activity. Surgical data was collected between October and December 2019 which is usually concurrent with a surge in medical admissions, hence a lower

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number of inpatient surgical procedures. This additionally meant that the high-risk surgical group may have been less likely to secure a bed in the ICU electively due to pressures within the critical care system. Whether a bed was sought was not recorded if one was not available. Furthermore, it was not possible to collect any data on medical admissions requiring Level 2 critical care if they were not admitted to the ICU. This is largely due to the lack of electronic care records in the wider hospital, and the labour intensive task that would have been required to track and clinically rank all inpatients. Therefore, the numbers in this report are likely to be underestimates.

What is key to this service evaluation is the fact that it was carried out prior to the SARS-CoV-2 pandemic, which put indescribable pressure on critical care services worldwide, not just in Ireland. With the services in CUH already stretched prior to the pandemic, it can only be assumed that in a post-COVID-19 landscape, staff, patients, and resources will continue to fall foul of these pressures unless action is taken to properly resource services according to evidence-based recommendations from expert bodies. Whilst critical care in the UK underwent significant modernisation in the last decade [29,38], Ireland appears to be falling behind, with little in the way of expansion or investment in resources since the publication of reported shortcomings in 2009 [8].

To conclude, critical care is filled with complexity, a lack of homogeneity in its utilisation, and countless confounding factors surrounding patient outcomes. This report has highlighted a number of potential areas of improvement within the current critical care service at CUH. The literature, alongside independent critical care reports, support the utilisation of a HDU in a major trauma centre to improve patient outcomes, as well as alleviate the burden on ICU, which continues to be a scarce resource. Local contextual factors that include economics, procurement and manpower were not explored here, but will obviously play a key role in inter-system variance. Further research, including a clinical trial with the introduction of HDU beds may demonstrate a reduction in morbidity and mortality for such a fragile patient population. To start this process, a cost analysis for the minimum eight patients per week needing Level 2 care by a posteriori definition from surgical services, and those from critical care occupying Level 3 facilities but requiring lower care level beds, would be pivotal. Certainly, this service evaluation highlights the need for debate amongst senior staff both at CUH, and at other similar level hospitals, at home and overseas, who might look to see if their critical care provision can be improved.

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Competing Interests

PG, KJ, SLG, FL – no competing interests declared.

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