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Research Article

An Evaluation of the Process of Care of Mechanically Ventilated Patients Outside of the Intensive Care Unit at the Eric Williams Medical Sciences Complex (Trinidad and Tobago)

R. Rambaran[1], D. Ventour[2*]

[1]Department of Anaesthesia and Intensive Care, Eric Williams Medical Sciences Complex, Trinidad and Tobago, [2]Department of Anaesthesia and Intensive Care, University of the West Indies, Jamaica, West Indies

ABSTRACT

Synopsis: The mortality rate was 50.0% among the patients ventilated in the general wards, 40.9% for the emergency department, 22.2% for the recovery room in the operating theatre. Overall the process of care was better than anticipated, however many aspects of patient care were indeed lacking and much more improvement is required.

Background: At the Eric Williams Medical Sciences Complex (EWMSC), a tertiary hospital in the developing country of Trinidad and Tobago, there has been an increased demand for intensive care. There persists a shortage of ICU beds resulting in the mechanical ventilation of critically ill patients at different wards in a non-ICU setting.

Objective: The aim of this study was the evaluation of the morbidity and mortality of these mechanically ventilated patients outside ICU, and assesses their process of care at these locations in hospital.

Design: This was a prospective, observational and non-interventional study conducted over a period of four (4) months at EWMSC.

Setting: EWMSC is a 500-bed hospital with only six (6) ICU beds available when fully staffed.

Patients: Forty-six (46) patients were mechanically ventilated outside the ICU during these four months. They were managed in the emergency department, operating theatre's recovery room, high dependency unit, general medical and surgical wards.

Results: The mean age was 52 years, with 67.4% of the patients being female.

The average APACHE score was 23.4 ± 10.08 SD, and the survival rate of patients with an APACHE II score >21 was 61%. Survivors were the younger patients of age 47.37 ± 17.95 SD, with lower APACHE II scores of 21.97 ± 10.02 SD.

Patients were ventilated for an average of 1.13+/-1.2 SD days prior to being admitted to the intensive care unit. IPPV at 48 hours was associated with increased mortality; however those who survived beyond this period were more likely to survive.

The mortality rate was 50.0% among the patients ventilated in the general wards, 40.9% for the emergency department, 22.2% for the recovery room in the operating theatre. All the patients managed in HDU survived to hospital discharge.

Most patients received basic vital signs monitoring, family counselling, and blood glucose testing, intravenous fluids as prescribed, sedation and neuromuscular blockade as prescribed, weaning from the ventilator, antibiotics, and inotropes vasopressors as prescribed. Overall mortality rate was 34.5%. The survival rate was 76.0% for the group admitted to ICU and 56.5% was the survival rate in the group that was never admitted to the ICU.

Conclusion: Patients mechanically ventilated in ICU had a lower mortality rate than those intubated and mechanically ventilated outside the ICU. The best survival rates were among the patients cared for in the recovery room of the operating theatre and high dependency unit. Overall the process of care was better than anticipated, however many aspects of patient care were indeed lacking and much more improvement is required. Adequate provision of ICU beds is a necessity. At EWMSC, there is the demand for more beds, staffing, equipment and implementation of ICU admission discharge policies, to effectively improve the quality of patient care and outcomes.

Keywords: Mechanical ventilation mortality; Non-ICU ventilation; Ward ventilation mortality

Correspondence to: D Ventour, Department of Anaesthesia and Intensive Care, University of the West Indies, Jamaica, West Indies, Tel:1-868-767-8158; E-mail: dale.ventour@sta.uwi.edu

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INTRODUCTION

The Eric Williams Medical Sciences Complex (EWMSC) is a public tertiary care institution in Trinidad with a 500-bed capacity from which six intensive care (ICU) beds available (nurse to patient ratio of 1:1). Despite the ICU bed ratio of 2.1 to 100 000 in Trinidad and

Tobago, comparable to the United Kingdom ratio of 3.5 ICU beds per 100 000 population, there persists a shortage of ICU beds in the public hospitals [1].

The demand for critical care is increasing worldwide due to an aging population, advancements in treatment for many chronic illnesses, epidemics, conflict and natural disasters [1]. At EWMSC there is the additional problem of the hospital providing care for a large catchment area of 455 000, nursing staff shortages and financial limitations as Trinidad and Tobago is a developing country with economic constraints [2-4].

At times of ICU bed shortages critically ill patients are mechanically ventilated on general medical surgical wards, emergency department, high dependency unit and even the recovery room of the operating theatre pending the availability of an ICU bed. These locations are frequently short staffed and managing a deteriorating critically ill patient requiring mechanical ventilation puts added strain on an overwhelmed ward. The staffs at these locations do not have ICU training and managing critically ill patients for the ICU team on duty is problematic with patients dispersed throughout the hospital. This is far from ideal and there is scarce information about the mortality and morbidity in ICU at EWMSC, there was no data on the patients who were mechanically ventilated outside ICU.

This observational, prospective non-interventional study was embarked upon to assess the morbidity, mortality and the process of care among the patients ventilated outside the ICU. The data collected was also used to compare the care and outcome of the patients who were managed in the ICU with those who were in a non-ICU setting.

Aims and objectives

This study was conducted to evaluate the process of care for these critically ill patients in a non-ICU setting at EWMSC. The care required is substantially greater for these cases, requiring more trained staff who understands the importance of each part of the patient care plan. Secondarily, to determine the morbidity and mortality of mechanically ventilated patients cared for outside of the ICU.

METHODOLOGY

This prospective, observational and non-interventional study was embarked upon the 9th October 2017 to the 28th February 2018. Patients ventilated in a non-ICU setting were included, general ward (medical and surgical), emergency department, high dependency unit and the recovery room of the operating theatre. Consent was granted by either the patient after their recovery or next of kin.

At EWMSC, apart from a 6 bed ICU, an 8 bed HDU, there are 5 surgical wards, 3 cardiology wards, 5 general medical wards, 1 thoracic respiratory medicine ward, emergency department and operating theatre. These wards are situated in different buildings with the closest ward to ICU being the high dependency unit. The responsibility of daily ward patient management is on the residents and specialists of medicine (internal, renal, cardiology, thoracic and neurology) and surgery (general, vascular, cardiothoracic, urology, neurosurgery and orthopaedic).

Few of these trainees have three (3) months ICU experience, which is not adequate to care for patients who are intubated and mechanically ventilated. They are not familiar with airway management and weaning adjusting ventilator settings. Alarms on the ventilator are set, and ICU is alerted if it sounds or any deterioration in the patient's vital signs. The thoracic medical team trainees also have little experience in managing these cases, having no ICU rotation as part of their training. Initial blood gas analysis would be done by referring teams, however all further blood gases and investigations were done by ICU. There are no assigned medical surgical doctors to assist with the care for mechanically ventilated patients outside ICU.

No physiotherapy is available in the wards; emergency department or recovery room, there is however one physiotherapist assigned to the HDU on weekdays, none on weekends. Nursing and medical surgical staff is not equipped to position, turn and assist with exercises required with physiotherapy. On the wards, equipment for recording and monitoring of basic vital signs (non-invasive blood pressure, heart rate and pulse oximetry) was limited. The infrequent monitoring on ventilated patients was repeatedly disturbed to monitor other patients on the general wards and emergency department. These interruptions occurred at least every 8 hours.

Accurate charting of daily fluid intake and output via urinary catheter, abdominal drains, chest tubes and nasogastric tubes was dependent on the nursing and auxiliary ward staff. Wards had limited functional leads for electrocardiography and probes for temperature monitoring. The increased workload on the wards and emergency department also reduced the frequency of blood glucose testing to a maximum of every 8 hours, if done at all. Suctioning was rarely done by nursing staff, as most felt uncomfortable with this procedure. ICU teams would suction, reposition and wean ventilator settings whenever patients were reviewed.

Sedation for these patients would be intermittent as the ward staffs were not familiar with diluting, starting and titrating infusions. Many times, the sedatives would be started by ICU staff but the empty syringes would not be refilled consistently on the wards and emergency department. Subsequently patients would become agitated, pull out monitors, intravenous lines, and endotracheal tubes and breathe asynchronously against the ventilator. Another issue was the continuation of sedation despite discontinuation orders for those improving patients. This slowed the weaning process and resulted in them spending an unnecessarily longer time receiving ventilator support.

Haemodynamically unstable patients required inotropes or vasopressors. The staffs on the general wards and the emergency department were inexperienced with using these infusions and often the infusions would not be refilled, causing patients to become profoundly hypotensive. These locations were not equipped to transduce central venous catheters, arterial lines and pulmonary artery catheters. Appropriate titration of these drugs when they were refilled, was also limited by non-invasive monitors and shortage of staff present on ward, to stay at the bedside and closely observe for fluctuations in a patient's blood pressure and pulse.

Referral process

Daily the ICU team on duty are referred patients who are deteriorating at various wards and in the emergency department. Mostly, these patients have no known diagnosis and minimal investigations, but have had a fall in their Glasgow Coma Scale (GCS) and require airway protection, ventilator support and stabilisation of haemodynamic parameters until diagnosis and prognosis have been established. The disadvantage of this basis of referral is that many times once it is discovered that the patient has a poor prognosis, most referring teams are unwilling to accept this and want full ICU intervention.

Another problem is that on arrival of the ICU team, most other physicians leave and continues with their ward rounds. They do not assist with the follow-up management of the patient. Additionally, many referrals are not made by the consultant or registrar of the medical or surgical team and trainees in these units use ICU as a surrogate for their senior review and intervention. All these factors contribute to a lot of unnecessary referrals, interventions and the mechanical ventilation of mostly poor prognosis patients outside of ICU. In the emergency department, patients are intubated by their trainees. Resuscitation becomes side-lined by requesting a ventilator and no other efforts are placed on patient care.

On review, the ICU consultant on call determines whether the patient is a candidate for ICU admission. There are no established ICU referral policy or admission criteria at this hospital and eligibility for ICU care depends on each consultant's decision.

If an assessed patient can benefit from ICU care arrangements are made in the unit by informing the nurse in charge and auxiliary staff to prepare a space and assign a nurse. Rarely all 6 beds are occupied. The more common occurrence is the lack of nursing staff to facilitate 1:1 care and at times due to cardiac surgery initiatives no physical bed space is available. When there is no available bed space and no ICU bed available in any other public institution, mechanical ventilation is started at the bedside, wherever in the hospital the patient is located. The ventilators used were manufactured by Viasys, Dräger or Maquet, at varying intervals, dependent on their availability.

Inclusion and exclusion criteria

Only patients over the age of 18 requiring invasive ventilation were included during this study. Exclusion criteria comprised of patients under the age of 18, do not resuscitate orders, pregnancy, use of non-invasive ventilation and refusal by patient and or next of kin to grant consent for data collection.

The protocol was reviewed and ethical approval was granted by the University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies, and Campus Ethics Committee.

Patients meeting the inclusion criteria were followed up until they were admitted to ICU and then again upon ICU discharge and or hospital discharge.

Information obtained was double checked by correspondence with the managing teams (physicians and nursing staff) involved in patient care. Patient's care was monitored for seven (7) days from the time of mechanical ventilation or until ICU admission to hospital discharge. Further follow up information recorded on the data collection sheet included the overall patient outcome; survive to ICU and or hospital discharge. ICU, HDU and ward patient admission discharge logs were checked this information.

Statistical analysis

Statistical analysis via SPSS version 24 (Statistical Package for the Social Sciences, SPSS Inc., Chicago, IL, USA). Pearson chi square test was used for categorical data and multivariate logistic regression models predicted effects of patient factors on outcomes.

Statistical issues

Despite the exclusion criteria, three (3) patients next of kin refusal refusal to grant consent and occasional lack of available ventilators, the estimated sample size of 46 patients was obtained. Our aim was to capture a snapshot over a three-month period; however the time frame was extended to meet the required sample size. The calculation used the following values: incidence population 68% (8), incidence 20% (3), type I/II error rate; alpha 0.05, beta 0.2, power 0.8 and the following formula.

$$N = \frac{poqo\left\{z1-\frac{\alpha}{2}+z1-\beta\sqrt{\frac{p1q1}{p0q0}}\right\}^2}{(p1-po)^2}$$

q0=1-p0

q1=1-p1

$$N = \frac{0.68*0.32\left\{1.96+0.84\sqrt{\frac{0.2*0.8}{0.68*0.32}}\right\}^2}{(0.2-0.68)^2}$$

N=7

p0=proportion (incidence) of population

p1=proportion (incidence) of study group

N=sample size for study group

α=probability of type I error (usually 0.05)

β=probability of type II error (usually 0.2)

z=critical Z value for a given α or β

RESULTS

During the study period 49 patients received mechanical ventilation in a non-ICU setting, among this group, 3 families did not grant consent and consequently these patients were excluded from the study. A total of 46 patients were followed up, 25 of whom were eventually admitted to ICU, while 21 patients received all their critical care management and ventilation outside the ICU. The mean age was 52 years, with the youngest being 18, oldest 85 years.

Most of the patients were female, comprising 67.4% of the patients and the remainder 32.6% were male, however there was no significance between gender and survival to hospital discharge.

Most patients were mechanically ventilated in the emergency department (47.8%), followed by the general wards (21.7%) and the high dependency unit (19.6%), with the least common location being recovery room in the operating theatre at 10.9%, as illustrated below (Figure 2).

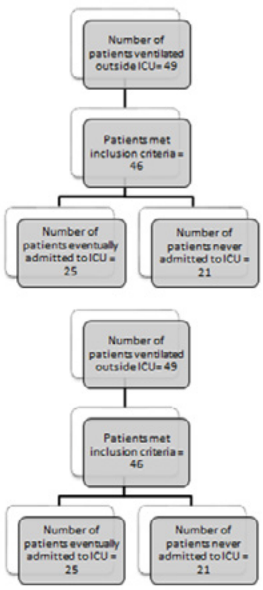

Figure 1: Illustrating patient enrollment.

However, the highest survival rate was seen in the OT recovery room group at 100% and the lowest survival rate of 50% in the general wards.

Average APACHE score was 23.4 ± 10.08 SD, and the survival rate of patients with an APACHE II score >21 was 61% and those with scores <21 at 71.4%.

No statistically significant correlation was found between ventilation in different locations outside ICU and patient survival, APACHE II score and hospital outcome, age and ICU outcome.

The duration of IPPV lasted an average 2.37 ± 2.51 days and the mean length of time patients were ventilated prior to being admitted to the ICU averaged 1.13 ± 1.2 days.

The most common diagnoses for the ventilated patients in this cohort were congestive cardiac failure, sepsis and status epilepticus. A decreased Glasgow Coma Scale of 8 or less was a main indication for intubation and the start of intermittent positive pressure ventilation (IPPV), followed by respiratory failure distress and post cardiopulmonary resuscitation.

Pearson Chi-Square Test was used to compare patient age, APACHE II, duration of IPPV and length of stay (LOS) before ICU admission with hospital outcome. Survivors were the younger patients of age 47.37 ± 17.953 SD, with lower APACHE II scores of 21.97 ± 10.026. Those who survived also had less days receiving IPPV at 2.10 vs 2.88 for the non-survivors.

Most of the patients were ventilated for less than 48 h outside ICU; however 14 patients were ventilated for more than 48 hours. Only one patient had an APACHE II score less than 10, all the other patients were very ill, 7 of which had APACHE II scores greater than 21.

There was no association found between IPPV time and APACHE II scores (Tables 1-6).

Table 1: Showing the outcome of mechanically ventilated patients from different locations in hospital.

(Location)	Dead (n)	Alive(n)	Total
Emergency Department	9	13	22
Operating Theatre	0	5	5
High Dependency Unit	2	7	9
General Wards	5	5	10

Table 2: Patient diagnosis at the time of ICU referral.

Diagnosis	Percent (%)
Trauma	17.4
Congestive cardiac failure	10.9
Chronic Obstructive Pulmonary Disease	10.9
Sepsis	8.7
Asthma	6.5
Post-operative	6.5
Myocardial infarction	4.3
Infective Endocarditis	2.2
Pneumonia	2.2

Table 3: Frequency of indications for IPPV

IPPV indication	Percent (%)
Low GCS (<8)	58.7
Respiratory Distress/failure	32.6
Post Cardiopulmonary resuscitation	8.7

Table 4: Analysis of age, APACHE II, duration of IPPV, LOS before ICU vs hospital outcome. Pearson Chi-Square Test.

	Hospital outcome	Number (n)	Mean (Standard Deviation+/- Standard Error of Mean)
Age	Dead	16	60.7 (19.7+/-4.9)
	Alive	30	47.4 (17.9+/-3.3)
APACHE 2	Dead	16	26.1 (9.9+/-2.5)
	Alive	30	21.9 (10+/-1.8)
Duration IPPV	Dead	16	2.88 (2.7+/-0.7)
	Alive	30	2.1 (2+/-0.5)
Length of ICU stay	Dead	16	1.2 (0.75+/-0.2)
	Alive	30	1.1 (0.5+/-0.35)
General Wards	5	5	10

Table 5: Comparison of IPPV time and APACHE II scores: <10, 11-20, >21.

	<10	11-20	>21	Total
IPPV<48 hrs	4	10	18	32
IPPV>48 hrs	1	6	7	14
Total	5	16	25	46

Table 6: Showing the percentage (%) of patients who received the basic standard process of care expected for critically ill patients.

	Received (Y%)	Not received (N%)	Not applicable
Physiotherapy	6.5	93.5	
Urine cultures	10.9	80.4	8.7
Tracheal aspirate cultures	10.9	78.3	10.9
Tidying per shift	15.2	84.8	
Blood culture	17.4	69.6	13
Hourly input/output charting	19.6	80.4	
Oral care	21.7	78.3	
Invasive / hourly vital signs monitoring	37	63	

DVT prophylaxis	37	63	
Temperature	39.1	60.9	
Nutrition	39.1	60.9	
Suctioning	41.3	68.7	
Nebulizers	50	50	
GI prophylaxis	50	50	
Inotropes/ Vasopressors	54.3	17.4	28.3
Antibiotics	58.7	37	4.3
Neuromuscular blockade with sedation	67.4	17.4	15.2
Weaning	76.1	23.9	
Sedation	82.6	13	4.4
IV fluids	84.8	15.2	
Blood glucose testing	84.8	15.2	
Family counselling	87	13	
Basic vital signs monitoring	97.8	2.2	

The overall survival rate of patients who received invasive mechanical ventilation outside the ICU was 65.2%. The survival rate of 76.0% for the group admitted to ICU and the survival rate in the group that was never admitted to ICU was much lower at 56.5%.

The process of care was assessed by numerous parameters listed on the data collection form (Figure 1). We found that greater than 50% of the patients received basic vital signs monitoring, family counselling, and blood glucose testing, intravenous fluids as prescribed, sedation and neuromuscular blockade as prescribed, weaning from the ventilator, antibiotics, and inotropes vasopressors as prescribed.

DISCUSSION

The mean age of patients ventilated outside our ICU was 52 ± 19.448 SD years, this was much younger than the average age of 78.9 ± 8.9 SD years old seen in Israel and 73.9 ± 12.6 SD years in Hong Kong. There was a clinically significant association between age and hospital outcome. Younger patients were more likely to survive, whereas those older than 47.3 years were more likely to die. There was a 100% mortality for the elderly (age >80 years) patients, who were mechanically ventilated outside the ICU. Another study, also found a higher mortality of 75% in their patients >80 years, compared to 65% mortality in ages <80 years [5].

Female gender was predominant at 67.4% unlike other countries where male gender was the majority, with 57.0% in China, 55.9% in Thailand and equal distribution seen in Jerusalem [3,6,7]. Analyses of these studies and from our evaluation, no correlation was found between gender and mortality rate, however a larger sample size is needed to determine if there is any link between gender and outcome.

The hospital bed capacity used in previous studies exceeds that available at EWMSC, 1100 beds in Hong Kong with 755 patients were ventilated outside the ICU during a 2.5-year period and 900 beds in Tel Aviv studied 437 patients over 1 year [5,6]. The most similar setting to our study, was illustrated by Hersch et al in Jerusalem, with a 500-bed hospital in which 65 patients were mechanically ventilated outside the ICU during a 6-month period [3]. They excluded surgical patients from their selection, in contrast to our inclusion of both medical and surgical patients [3]. They had approximately 1.5 times our number of patients that were mechanically ventilated in a non-ICU setting, 20% of this group survived to discharge from hospital, whereas our survival to hospital discharge was 52.1% (3). Our overall mortality rate of 34.8% was less than expected in comparison with other studies: 72.1% to 74% in Israel and 68.8% in Thailand, with the worst mortality at 89.1% determined by Tang et al, in Hong Kong [4,6,7]. Those studies showed a higher mortality in the non-ICU ventilated group, than the patients cared for in ICU, as anticipated. The observed ICU mortality for the mechanically ventilated patients outside of ICU, in Trinidad and Tobago was at 29.7%, which is considerably less than the actual mortality rate seen in other countries.

The higher mortality in Israel, was attributed to the poor prognosis of the non-ICU ventilated patients, with APACHE II scores of 27 ± 7, age 69 ± 13 years, low serum albumin, lower Karnofsky scores, a reduced nurse to patient ratio (1:10) and less available monitoring [3]. Contributing factors may also be the high rate of endotracheal tube events (accidental extubation, dislodgment, disconnection, kinking and obstruction by secretions) in their ward group 40 vs 7 from the ICU group [3].

One retrospective study from Tel Aviv Israel, included non-surgical and non-trauma patients in their analysis [5]. In their hospital, apart from ICU, six medical wards had one room designated for mechanically ventilated patients, in their non-ICU setting where they could provide a level of care, almost like a high dependency unit [5]. VELA ventilators [USA] were used; patients were kept supine at a 30-degree angle on air-filled mattresses [5]. They maintained a consistent regimen for position changes that despite the staff constraints, was adhered to as part of pressure sore prevention protocols [5]. They were also able to provide continuous electrocardiography and surveillance of vital signs. There were similarities with our general ward setting, as were unable to provide and transduce central venous catheters, arterial lines or pulmonary artery catheters [5]. While our general wards and emergency department did not have any exclusively dedicated nurse, or one staff physician for these patients, in Israel one nurse and a doctor was assigned for these critically ill patients [5]. Despite these measures there was no improvement their mortality rate, likely due to their patients being elderly and having poor functional status prior to hospital admission [5].

Similarly, in our wards there was also a limited three (3) month experience and training in ICU among the medical and surgical ward staff [5]. Conversely, they had respiratory therapists assisting in patient care, but they were not allowed by law to make changes on the ventilator [5]. In our setting, there are no assigned respiratory therapists to function in that capacity. Suctioning, position changes, weaning, and follow up with regards to fluid balances, blood gas analyses and pending investigations were done by the ICU team upon review at those non-ICU locations.

Most patients were found to be ventilated in the emergency department at EWMSC; few studies have evaluated a predominantly mechanically ventilated group in the emergency department. A multi-centre, prospective, observational study in Colorado (United States), found that ventilation in the emergency department for greater than seven (7) hours, had significantly higher in-hospital mortality at 45.9% versus 29.4%, in the group ventilated for less than seven hours before ICU admission (9). The greater than seven hour group spent a longer time mechanically ventilated however there was no impact on the length of hospital or ICU stays (9).

Conversely, the length of time patients received mechanical ventilation in our emergency department exceeded 7 hours for all patients and the mortality rate among that group was 40.9% (9 out of 22), ranking as the second highest mortality when compared to the general ward ventilated group of 50.0% mortality (5 out of 10). No statistical significance between type of non-ICU location and mortality was found. Notably, the possible closer monitoring, albeit inconsistent and dependent on the staff availability per shift, in the critical area of the emergency department, may have led to the lower mortality rate. This rate is still higher than the group managed in the operating theatre, likely due to the limited staff in the emergency department. Their staff has no critical care training and at times, there may be only two (2) trained nurses on shift for the entire emergency department. Periodically, another patient must be simultaneously resuscitated. This staff shortage results in no one being available to monitor and continue care for the critically ill patients ventilated in their critical bay.

Our general wards when fully staffed run at a 1:11 nurse to patient ratio, whenever there are staff shortages this ratio becomes approximately 1: 22. The increasing demands of a critically ill patient are seldom met as we discovered in the process of care assessment. It is logistically impossible on a general ward that is at maximum capacity, to have adequate equipment, monitoring and all patient care needs met, especially at times of 1:22 nurse to patient ratio. Despite this discrepancy, the process of care on the wards was surprisingly better than initially perceived. The input and frequent reviews by the ICU staff, likely contributed to the improved care and overall less mortality in our setting, when compared to other countries where there are critically ill patients managed outside the ICU.

The group mechanically ventilated in the recovery room of the operating theatre survived to hospital discharge. The ICU bed space at EWMSC is limited, and with the ever-increasing demands, there must be careful selection of the best possible candidate. Selecting which patient can benefit the most and has the best chance of recovery with a good quality of life, is a difficult decision. Often, the post-op surgical critically ill patients receive preference, as the majority have a reversible condition and their admission into the ICU will ameliorate the congestion in the post anaesthesia care recovery room. When patients are mechanically ventilated in the recovery room, this results in the delay and at times, the cancellation of elective and urgent surgeries. The room as must be screened off, with ventilators and pumps occupying further space in the recovery bay with additional monitors.

The nursing staffs are rearranged to help care for these critically ill patients, at times reassigning nurses from an elective list to facilitate this demand. The flow and organisation in the operating theatre becomes disrupted. Meanwhile, there are no ICU trained nurses in this setting, thus the anaesthetic staffs assigned to the emergency list is charged with most of the care and interventions needed for these patients. Frequent assessments are not possible, as they also must continue with the ongoing emergency cases. Intermittently, these patients are reviewed by the ICU team, however this is limited as the recovery room is a building away from the ICU. The on-duty ICU team also manages patients within the unit, those mechanically ventilated in other non-ICU locations and assess the referrals made for deteriorating patients throughout the hospital.

Despite all these disadvantages, these patients received better care and timely interventions in their management due to one nurse being assigned to the patient, the assistance of anaesthetic staff with ICU experience and medical surgical teams conducting their rounds up to twice daily with a consultant present. These factors may have contributed to the overall high survival rate in comparison to the critically ill patients managed at other locations.

The high dependency unit did not have a dedicated physician assigned for these patients yet the group ventilated there had a lower mortality rate of 22.2%. The maximum nurse to patient ratio of 1:3, and a recent change of more ICU trained nurses stationed in the unit resulted in overall improved care. They were versed in all aspects of patient care and more astute in noticing changes of a deteriorating patient and alerting ICU staff. Sufficient equipment for continuous basic and invasive monitoring, physiotherapy services and the proximity to ICU also allowed for multiple patient reviews daily. These features all had a positive impact on the outcome of these mechanically ventilated patients in the high dependency unit.

The most common diagnosis was trauma, congestive cardiac failure and exacerbation of chronic obstructive pulmonary disease. The predominant reason for IPPV was listed as low GCS (58.7%) and respiratory distress (32.6%), which was comparative to the findings in Tang et al where pneumonia (22.6%), acute coronary syndrome (16.2%) and cerebral haemorrhage (15.5%) were the most common diagnosis [6-9].

APACHE II utilises 12 physiological variables, age and chronic health status and was selected as the severity of illness scoring system for this study [10]. Other versions APACHE I, III and IV were not used in similar studies and were difficult to calculate within the first 24 hours in our non-ICU patients. Many times, the parameters for the Glasgow Coma Scale would not be specified, blood investigations for albumin and bilirubin are not available in the lab as rapidly as renal function, electrolytes and complete blood count to use another scoring system. Referrals to the ICU are frequently made without these values available and only when the ICU team reviews, requests and follow up of appropriate investigations are conducted. Our laboratory results must be collected manually and as there is no electronic database allowing quick access of the results or notification system to alert staff that results are ready for pick-up. Previous studies on APACHE II showed good discrimination but there was a difference from the predicted mortality calculated, with mortality being higher than expected [10]. There are limitations to the APACHE II criteria use in our population, as it was developed in North America, in 1985 [10]. Local customisation to make it more applicable to the patients in our setting who have different demographics is needed.

A high mortality rate was anticipated for the group of patients mechanically ventilated outside the ICU. In general, there is a tremendous lack in basic standard care due to the depleting resources and staff constraints in this developing country. There is a scarcity of data for our institution, but a study by Hariharan et al 2007 showed that the ICU mortality rate of 29.7% and the predicted mortality rate was 32.9%, with a standard mortality ratio of 0.9 [11].

At that time, this ratio was comparable to the United States and UK, indicating a comparable level of ICU care in Trinidad. Simplified Acute Physiology Score II (SAPS II) score was used, and the average score was greater at 40.5 which were close to the UK's average of 42.1, however a lower average score of 32.1 was seen in North America at that time [11]. This scoring system was developed from a different population and has not been validated for our case-mix of patients. They also encountered difficulty in assessing the demand for ICU beds across the various hospitals in the country due to the lack of data [11]. Nonetheless, they did note that the overall bed occupancy was 66.4% (optimal occupancy range between 60 and 70%), one public institution had an occupancy of 95.1% [11]. This indicates that even at that time, there was a shortage of ICU beds.

Statistically there was no significance with the duration of IPPV and hospital outcome in our setting. However, over 48 hours of IPPV outside the ICU, resulted in a greater mortality of 50.0% compared to patients ventilated less than 48 hours at 28.1%. The highest mortality occurred at day 2, but once the patients survived the beyond this, they were more likely to survive. The importance of a 48-hour mark is likely due to the development of ventilator associated pneumonia, which possibly led to the prolonged length of stay in hospital which was used as surrogate, showing increased morbidity among this group of patients.

Several of the basic standard care needs were not met, especially suctioning, administration of nebulizers and antibiotics, weaning of the ventilator settings which contributed to the morbidity and mortality. The required cultures (blood, urine, and tracheal aspirate), tidying, oral care, hourly input output charting, continuous invasive monitoring, DVT prophylaxis and temperature monitoring were lacking in most of the patients. Shortage of staff to aid in tidying, monitoring, checking and documenting the essential parameters was a main factor. Limited equipment, at times even basic blood pressure cuffs, pulse oximetry, electrocardiography and transducers especially in the general ward setting also compounded the problem.

Suctioning of the endotracheal tube facilitates toileting and clearance of secretions from the tracheobronchial tree plugging the airways, keeping the airway patent, boosting ventilation and oxygenation. Inadequate suctioning contributes to atelectasis, infections (ventilator associated pneumonias; VAP), respiratory compromise, obstruction of the endotracheal tube, haemodynamic changes and death [12]. Oral pharyngeal hygiene is quite often taken for granted particularly in the outside ICU setting where staff struggles to find equipment for basic care and monitoring. This aspect of patient care is also essential as lack of oral care is linked to the increase in likelihood of ventilator associated pneumonia (VAP) [13].

Pressure ulcer formation in the critically ill patient is more likely to occur, in comparison with other more stable patients in the general wards. The cause is multifactorial, due to urinary and or faecal incontinence, immobility and impaired nutrition among these ill patients. Mechanical ventilation, use of inotropes vasopressors, organ failure and resultant poor tissue perfusion and oxygenation also contribute to the formation of ulcers [14,15]. Prevention strategies include establishing a multidisciplinary task group, protective dressings, use of alternating low-pressure mattresses, use of risk assessment tools e.g. CALCULATE and turning regimens e.g. every 2 hours for the very high-risk group of critically ill patients [16]. In the non-ICU setting, most of the patients were turned at a maximum of once every 12 hours; no risk assessment calculators or protective dressings were available. While the patients located in the high dependency unit were cared for on alternating low-pressure mattresses, this was not available in the emergency department, recovery room or general wards. This may also have been a factor adding to the morbidity and longer length of stay among them.

Physiotherapists are a fundamental part of the multidisciplinary team involved in the care of ICU patients. These patients spend less time on the ventilator, reduced hospital and ICU length of stay, with an overall improved quality of life, reduced incidence of ICU acquired weakness [17,18]. This acquired weakness has been linked shown to increase the six (6)-month post ICU mortality rates [19]. In our setting, all the non-ICU locations apart from HDU, do not have assigned physiotherapists, thus these patients did not receive any formal rehabilitation. Chest physiotherapy was intermittently done on an ad hoc basis by ICU doctors, when these patients were reviewed. This may have contributed to the higher mortality rate; increase in ICU acquired weakness and possible longer length of stay, contributing to increased morbidity among those who were eventually admitted to the ICU. Further studies are needed on the cost analysis of providing more physiotherapists in our tertiary care institution, as it may be more cost efficient overall in comparison to the cost of increased length of stay and morbidity in hospital per patient.

Critically ill patients are at a high risk (prolonged immobilization, mechanical ventilation, and vascular injury or surgery) for the development of venous thromboembolism (VTE) [20]. There is an association with the lack of early VTE prophylaxis (within 24 hours of ICU admission) and increased mortality [21]. Both low molecular weight heparin and unfractionated heparin, reduce the risk of VTE formation [22]. Mechanical alternatives (e.g. graduated compression stockings and intermittent pneumatic compression devices) are used when anticoagulants are contraindicated, but they have not been proven as more efficacious in comparison with pharmacotherapy [23,24].

At EWMSC, among the mechanically ventilated patients outside ICU, 37.0% of the patients without contraindications received a form of VTE prophylaxis. Most of the reasons being lack of drugs availability, staff was unable to administer medication, or no appropriate size of the graduated compression stockings. Only two intermittent compression devices are available in this hospital and these are reserved for use in surgical critical care cases. None of the patients had pre-existing or received inferior vena cava filter insertion during their hospital stay.

A regular occurrence in the non-ICU setting was medication prescribed, was not administered to the patient. This ranged from sedation, inotropes vasopressors, antimicrobials and gastrointestinal bleed prophylaxis. On closer inspection of the ICU patients' diagnosis, most they have high risk factors for gastrointestinal haemorrhage [25]. In ICU patients, gastric mucosal erosions start in the first 24 hours of admission [26]. Stress ulcer prophylaxis has been associated with a decrease in risk for gastrointestinal bleeding, but it can lead to an increase in gastric pH (higher risk of non-sterile aspiration), increase in gastrointestinal bacterial overgrowth, bacterial translocation, increased risk of Clostridium difficile infections and no impact on mortality [26]. The best methods and drugs for prevention have been debated; most trials and Meta analyses showed that proton pump inhibitors were superior to H2 antagonists in reducing gastrointestinal bleeding rates.

Only 50% of the patients in our study received either proton pump inhibitors or H2 antagonists. These critically ill patients fall into the high-risk category and were placed at a greater risk for adverse outcomes due to deficiencies in medication administration.

Enteral feeds are protective by reducing the imbalance of splanchnic hypoperfusion, prostaglandins, bicarbonate, nitric oxide and increased endothelin 1 which lead to gastric mucosal damage giving rise to stress related mucosal disease [26]. It optimizes intramucosal pH and reduces gastrointestinal inflammation from reperfusion injury [26]. Enteral feeds alone have not been shown to reduce gastrointestinal bleeding rates or mortality from this, but the combined use with pharmacotherapy can have a synergistic protective effect but more research is required in this field [27]. Most of the patients in our study did not receive any form of nutrition until they were admitted to the ICU or HDU and thus were at a greater risk of stress related mucosal disease. Early enteral feeds (within 48 hours) is preferred as it has been shown to reduce infection rates and decrease hospital stay among critically ill patients, of note, no consistent data available on whether it reduces mortality rates.

Antimicrobial stewardship programmes are recommended in all health care institutions. At our institution, no such programme is operational although steps are being incorporated e.g. limiting prescription of agents without culture reports classifying the organisms' sensitivity profile. If cultures are done, a minimum of 48-72 hours is needed before a possible positive result is identified. In this study, 8.7% of the patients ventilated outside ICU were diagnosed as likely sepsis, only 10.9% had urine and tracheal aspirate samples sent and 17.4% had blood cultures done. Cultures should be taken as early as possible to avoid delay in starting antibiotics, can lead to reduced ICU stay, guide antimicrobial stewardship programmes and limit overuse of antimicrobials. These goals were not achieved in the non-ICU setting, likely contributing to the higher mortality in these patients.

Hourly input and output charting is technically challenging, requiring vigilant staff. The overwhelmed staff on the general wards and emergency department cannot keep up with this measuring and documentation regimen. Positive fluid balances have been associated with higher mortality rates in critically ill patients [28,29]. The proper management of patient fluids, accurate charting at least hourly is required, especially since invasive monitoring is not available in the emergency department and general wards. This task is difficult and time consuming, particularly when there may be a nurse to patient ratio ranging from 1:10 to 1:22. Education is needed among auxiliary nursing staff about the negative impact on patient outcome, when there is a lack of accurate and timely recording of input and output [30]. At the HDU and recovery room of the operating theatre, arterial lines and central venous catheters can be transduced; additionally the use of bedside ultrasound can be facilitated in these settings.

Furthermore, since there were scant staffs, particularly on night shifts, vital signs were not logged; invasive monitoring could not be started in the cases where transducers were available, as cannulas could be dislodged and go unnoticed for hours. Consequently, weaning from the ventilator and inotropes vasopressors was delayed and patients would remain on haemodynamic support unchecked until admitted to ICU or their demise. There was a correlation between patients who required and received inotropes vasopressors and improved survival rate (72.0%), comparable to the group who did not require this intervention (76.9%). Unfortunately, eight (8) patients did not receive these infusions and resulting in only two (2) patients surviving to hospital discharge (survival rate 25.0%).

Inotropes were not started due to lack of drugs available on site, staff becomes busy with other patients and forget to source medications from other wards or inform ICU of this issue. Pumps were not refilled resulting in profound hypotension. Most discrepancies tend to occur at change of shift, when staff attends to the rest of the ward or emergency department, or the oncoming staff has no experience mixing and starting these infusions. Titrating these medications to achieve the desired blood pressures could only be done intermittently by ICU staff and some nurses with more experience with critically ill cases. The inability to establish invasive monitoring also restricts optimal management in these haemodynamically unstable patients. Non-invasive blood cuffs are limited in the non-ICU setting, finding an appropriate size that works consistently is another dilemma.

Differences in nurse to patient ratio, equipment and facilities for mechanical ventilation and multiple organ system support between these countries with struggling economies. Trinidad and Tobago's budget healthcare allocation has dramatically increased from 1.58 billion TT dollars in 2003-2004 to 6.02 billion TT dollars by 2017-2018 [2]. Despite this greater expenditure, there has been no expansion in the ICU capacity (beds, equipment and staff) at EWMSC. There persists a rising demand for intensive care services in the public health care system which has yet to be achieved.

Meanwhile, we suggest maximizing the use of our depleting resources, one way is by focusing the intensive care services on the patients with the most reversible diagnosis. Frequently patients with multiple co morbidities and poor functional capacity at home are found unresponsive, intubated at their primary health care facility then transferred to EWMSC for further management. Many medical and surgical teams are unwilling to clearly establish a do not resuscitate status where needed; in turn demanding ICU intervention. Launching a triage policy for critically ill patients to reduce the ad hoc triage decision per case is mandatory. A similar problem was observed in Israel where poor prognosis patients who would not benefit from intensive care were mechanically ventilated on their medical wards.

Do not resuscitate orders and advanced directives are far and few. Most of the patients and relatives have no prior knowledge of these processes. Additionally, many religious organizations have different beliefs and some may not accept futility of care among those patients with poor prognosis. Charlson and or acute physiology score can be used to objectively guide evaluating critically ill patients as it considers the multiple co morbidities and functional limitations. This should not preclude the need for studies on scoring systems in our population to determine which one is the most valid. APACHE II only had a 60% correlation to the patients in this study. A scoring system applicable to our population will guide teams in distinguishing the poor prognosis patient from an ICU candidate can also assist in reducing the number of patients who are started on mechanical ventilation, which can reduce the number of these patients in the non-ICU setting. Further research that can be done is analysing the 28-day mortality and 3-month post discharge among the patients mechanically ventilated outside of the ICU. Additionally, a larger study is needed, possibly over a two-year period, at least with patient follow up to discharge.

CONCLUSION

The mortality rate outside the ICU for these critically ill patients receiving mechanical ventilation was higher than the mortality rate of patients within ICU. Patients ventilated in the recovery room of operating theatre and high dependency unit had a higher survival rate and better process of care than the general wards and emergency department. A greater number of ICU beds are needed in public hospitals and the establishment of ICU admission discharge policies optimize the use of our limited depleting resources and staff constraints in this developing country.

AUTHOR CONTRIBUTIONS

D. Ventour oversaw the project, data analysis, performed the statistical analysis and drafted the final manuscript.

R. Rambaran conceptualized the paper, collected the data and performed the initial write up.

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