THE IMPACT OF TIME TAKEN FROM REFERRAL TO ADMISSION INTO THE INTENSIVE CARE UNIT ON MORTALITY AND DURATION OF ADMISSION

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MBChB, D.A. (UZ)

A Thesis submitted in partial fulfilment of the requirements for the degree of Masters in Medicine (Anaesthesia)

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June 2014
DECLARATION

I, Dr D Pagwiwa, declare that this submission is my own work. I am submitting it for my Masters degree in Medicine (Anaesthesia and Critical Care Medicine). I attest that it has not been submitted in part or in whole to any university or any other institution of higher learning.
ABSTRACT

Objectives

This study investigated the effect of time taken from patient referral to ICU to the admission time and its effect on patient mortality and length of stay.

Methods

A prospective descriptive study of emergency medical and surgical patients admitted into the adult ICU at Parirenyatwa and Harare central hospitals between the months of February 2014-June 2014. Patients for whom an ICU bed was requested were followed up from the date and time they were referred to the date and time of admission. Further follow up of the length of stay and mortality was done. Delay was defined as a lead time of at least 4 hours and was compared with patients admitted within 4 hours of referral. Confounding variables examined were sex, National Early Warning System Score (NEWS), and age.

Results

A total of 128 patients participated in this study, 48% were delayed by more than 4 hours from referral to admission whilst 52% were admitted within 4 hours with an average lead-time of 7.5 hours and more male patients were delayed by >4 hours(63% p=0.003). Patients delayed for more than 4 hours had a higher mortality (22.9%) compared to those admitted within 4 hours (18.3%). There was no significant effect of lead time to length of stay in ICU.

Conclusion

There is an association between time taken from referral to admission and mortality. Earlier ICU admission will lead more likely to better mortality rates in ICU.
ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to my supervisor, Dr F Madzimbamuto for guiding me through this study and helping me to open my mind when faced with difficult situations. I would also like to offer my special thanks to Dr S Shumbairerwa, my teacher and mentor for the inspiration and advice. Special thanks go to all my tutors in the Department of Anaesthesia and Critical Care Medicine and my fellow classmates for the support throughout this project. I also wish to acknowledge the help provided by Mr K Chimunda for the assistance provided in my statistics. I also wish to thank my family and friends for the support throughout my study.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
</tr>
<tr>
<td>HDU</td>
<td>High Dependency Unit</td>
</tr>
<tr>
<td>PGH</td>
<td>Parirenyatwa Group of Hospitals</td>
</tr>
<tr>
<td>HCH</td>
<td>Harare Central Hospital</td>
</tr>
<tr>
<td>ICN</td>
<td>Intensive Care Nurse</td>
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<tr>
<td>SHO</td>
<td>Senior House Officer</td>
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<tr>
<td>TBI</td>
<td>Traumatic Brain Injury</td>
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<tr>
<td>SRMO</td>
<td>Senior Resident Medical Officer</td>
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<tr>
<td>NEWS</td>
<td>National Early Warning Score</td>
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<td>APACHE</td>
<td>Acute Physiology and Chronic Health Evaluation</td>
</tr>
<tr>
<td>MAP</td>
<td>Mean Arterial Pressure</td>
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<td>GCS</td>
<td>Glasgow Coma Scale</td>
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<td>SAPS</td>
<td>Simplified Acute Physiology Score</td>
</tr>
<tr>
<td>MPM</td>
<td>Mortality Prediction Model</td>
</tr>
<tr>
<td>SOFA</td>
<td>Sepsis Related Organ Failure Assessment</td>
</tr>
<tr>
<td>CCM</td>
<td>Critical Care Medicine</td>
</tr>
<tr>
<td>RRT</td>
<td>Rapid Response Teams</td>
</tr>
<tr>
<td>MET</td>
<td>Medical Emergency Teams</td>
</tr>
<tr>
<td>HBN</td>
<td>Hospital Building Note</td>
</tr>
<tr>
<td>SCCM</td>
<td>Society of Critical Care Medicine</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
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<td>--------------</td>
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</tr>
<tr>
<td>LOS</td>
<td>Length of Stay</td>
</tr>
<tr>
<td>JREC</td>
<td>Joint Parirenyatwa Hospital and College of Health Sciences Research Executive Committee</td>
</tr>
<tr>
<td>BP</td>
<td>Blood Pressure</td>
</tr>
<tr>
<td>SBP</td>
<td>Systolic Blood Pressure</td>
</tr>
<tr>
<td>NYHA</td>
<td>New York Heart Association</td>
</tr>
<tr>
<td>AIDS</td>
<td>Acquired Immune Deficiency Syndrome</td>
</tr>
<tr>
<td>Mg/dl</td>
<td>Milligrams per decilitre</td>
</tr>
<tr>
<td>µmol/l</td>
<td>Micromoles per litre</td>
</tr>
<tr>
<td>G/L</td>
<td>Grams per Litre</td>
</tr>
<tr>
<td>SBP</td>
<td>Systolic Blood Pressure</td>
</tr>
<tr>
<td>%</td>
<td>Percentage</td>
</tr>
<tr>
<td>SAP3</td>
<td>Simplified Acute Physiology Score</td>
</tr>
<tr>
<td>HR</td>
<td>Heart rate</td>
</tr>
<tr>
<td>PaO₂</td>
<td>Partial pressure of oxygen</td>
</tr>
<tr>
<td>FiO₂</td>
<td>Fraction of inspired Oxygen</td>
</tr>
<tr>
<td>UO</td>
<td>Urine output</td>
</tr>
<tr>
<td>K⁺</td>
<td>Potassium</td>
</tr>
<tr>
<td>Na⁺</td>
<td>Sodium</td>
</tr>
<tr>
<td>TLC</td>
<td>Total Lung Capacity</td>
</tr>
</tbody>
</table>
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INTRODUCTION

An Intensive Care Unit (ICU) like the name suggests, is a specialised unit in a hospital where the care of patients who are deemed critically ill but recoverable, who need monitoring or specialised techniques by specialised personnel is done 1. The use of these units has led to a reduction in hospital mortality of up to 60% 2,3. Historically, the concept of intensive care goes back to a time when the understanding of human physiology occurred. The understanding of the process of oxygenation and that life is an oxidative process, has led to emphasis on the respiratory support and oxygen inhalation 1

The units are characterised by having space, equipment, specialised staff and provision of monitoring continuously around the clock of the vital patient physiological parameters. Patients with various pathologies can benefit from this unit, examples of these can be:

1. Patients requiring artificial ventilation, cardiovascular support and renal support.
2. Major trauma patients
3. Major metabolic disturbances e.g. diabetic ketoacidosis.

The growth of the idea also came with advances in methods of life support. Since 1896 automatic artificial ventilation of the lungs during chest surgery was known. Tuffcer and Hallian in France successfully intubated and administered artificial ventilation using part re-breathing valve 1, laryngoscopy and intubation of the lungs was made popular by Cheraker and Jackson in the early 20th century.
Advances in methods of administering artificial ventilation were a crucial development in Critical Care. Cecil and Philip Drinker developed a positive and negative pressure tank which was successfully used in a child at Boston Children’s hospital \(^1\).

With the introduction of neuromuscular blocking agents into clinical practice in 1948, the practise of anaesthesia was revolutionised and it was redefined as a triad of narcosis, analgesia and muscle relaxation \(^4\). This facilitated intubation and easier ventilation of patients and experience was gained in the use of these.

Several key events and figures are associated with the development of Intensive Care Units. In 1923, Florence Nightingale, the founder of modern nursing demanded that the most critical patients injured during the Crimean War be watched more closely.

This created an early focus of the importance of geographical separation for critically ill patients \(^1,2\). This patient population would then receive more attention and resources from the medical and nursing staff available. In 1923, Dr Walter E Dandy, an American neurosurgeon and scientist opened a special three bed unit at Johns Hopkins Hospital in Baltimore for critically ill neurosurgical patients\(^1,2\).

In 1930, Dr Martin Kirschner built a combined post operative recovery / intensive care ward in Germany at the University of Turbigen \(^1\). 

During the polio epidemic in Copenhagen in 1952, several patients developed acute flaccid paralysis and respiratory failure. This left them in need of some form of artificial ventilation, as thousands of medical students and nurses had to be recruited to take turns to continuously manually ventilate patients with self inflating bags with one way valves. The “Iron Lung”
apparatus, which is basically a negative pressure chamber which works by producing a negative pressure around the chest and abdomen whilst the face is exposed to the atmosphere resulting in chest expansion and drawing of air into the lungs was developed. This is a bulky apparatus which was expensive to built and unable to cope with the number of patients requiring artificial ventilation.

This also led to the establishment of the first ICU at Kommune Hospital Copenhagen in December 1,2, 1953. This unit was opened by Danish anaesthetist Bjorn Ibsen 2.

With this huge success in preventing death from respiratory failure by artificial ventilation using Iron Lungs, a whole new range of diseases and complications were made amenable to treatment e.g. chest injuries, tetanus and post operative respiratory failure. This new knowledge was initially spread amongst a group of enthusiasts who communicated personally, not through medical journals, therefore spread of this knowledge to different centres was slow.

The development of cardiopulmonary resuscitation in the 1960s led to increased treatment options for patients, and with the discovery of defibrillation which had been in development since the 1930 5 and pharmacological anti-arrhythmia control, critically ill patients had a higher chance of survival and needed more advanced monitoring.

The 1960’s were characterised by rapid growth of intensive care medicine and throughout the 1970s the scope of Intensive Care increased further. To date care of critically ill patients covers a wide range of life threatening respiratory, neurological, cardiovascular, metabolic disorders caused by many medical, surgical and paediatric conditions.
By 1960 almost all hospitals had a recovery unit attached to the operating rooms \(^{(1)}\). Specialised shock units were used for the severely injured during the Second World War. The polio epidemics in Copenhagen led to the opening of respiratory units for patients who required mechanical ventilation. Dr Max Harry Well and Dr Herbert Shubin opened a four bedded ward in Los Angeles County Medical Centre, United State of America which was meant to improve the recognition and management of complications in critically ill patients and this was followed by the opening of a multi-disciplinary ICU at Baltimore City Hospital by Dr Peter Safar \(^{1}\). ICUs began to be created across Europe, United States of America and Australia and eventually to the rest of the world.

Intensive Care Medicine is a relatively young speciality that has seen rapid growth since its inception and is intertwined with other disciplines because of the heterogeneous patient population. The past decades have seen an increased understanding of different pathophysiological disease states and with continuing learning of how to manipulate physiology, biochemistry and immunology, a lowered mortality in critically ill patients looks promising. Despite this, clinicians often fail to manage patients adequately because appropriate therapy is started when it is too late \(^{3}\). The lack of ICU bed availability is a commonly reported problem and has led to delays in patient admission and failure to admit some patients at times but the effect this has on patient outcome is still unknown at Parirenyatwa Group of hospitals (PGH) and Harare Central Hospitals (HCH). The aim of this study is to determine if the time taken between referral of an emergency medical and surgical patient to ICU and admission into ICU has any effect on patient mortality and length of stay.
LITERATURE REVIEW

In Zimbabwe, there are 4 major referral hospitals located in its 2 major capital cities of Harare and Bulawayo. Of the two cities, Harare has the main referral hospitals namely Parirenyatwa Group of Hospitals and Harare Central Hospital.

**Parirenyatwa Group of Hospitals (PGH) Intensive Care Unit Ward B7**

Parirenyatwa Hospital was opened in 1974 and was then called the Andrew Fleming Hospital. In 1982, the hospital was renamed Parirenyatwa Hospital, in honour of the first black Zimbabwean to qualify in medicine Dr Tafirenyika Parirenyatwa. The hospital is located in Central Harare and is the principal teaching hospital for the University of Zimbabwe College Of Health Sciences. The Intensive Care Unit at PGH was first commissioned in 1977 and has a maximum capacity of 10 beds. Of the 10 available spaces in PGH ICU, an average of 6 patients is usually admitted at a time due to shortages of nursing staff and functioning ventilators.

**Staff Establishment**

There is 1 sister in charge who is trained in Intensive Care Nursing with several years experience working in the unit. The rest of the nurses include 9 intensive care nurses (ICNs), 10 senior registered general nurses (RGNs) and 15 junior registered general nurses, making a total of 38 nurses. Other staff members include 5 nurse aides, 2 general hands, 1 cleaner and 1 housekeeper.

A dedicated consultant anaesthetist is in charge of the unit during normal weekdays (8am-4pm), and after work hours, the consultant on call in theatre takes over management of the
unit. A Registrar is normally also dedicated to the unit during weekdays. On weekends, the consultant on call takes responsibility of both theatre and ICU together with either the registrar or Senior House Officer (SHO) on call.

**Statistics and disease pattern at Parirenyatwa hospital ICU**

The charts below show admissions, discharges and deaths of patients admitted at PGH ICU for the years 2012, 2013 and part of 2014. Note that records for the 2\textsuperscript{nd} and 3\textsuperscript{rd} quarters of 2012 were omitted as the records are missing. These were obtained from the monthly nursing statistics forms kept in the intensive care unit.

The ICU mortality rate was calculated using the following formula:

\[ \text{ICU Mortality} = \frac{\text{Total number of ICU Deaths}}{\text{Total number of admissions to ICU for the given period}} \]
Chart 1  2012 1st quarter summaries of admissions, discharges and deaths

The ICU mortality rate for the 1st quarter of 2012 = 39%

Chart 2: Statistics from September-December 2012
ICU mortality rate for September- December 2012 = 42%

Chart 3: 2012 disease pattern for the 1st quarter

Chart 4: Admissions, discharges and deaths for the year 2013:
ICU mortality rate = 34.4% for the year 2013

The top five conditions are not included for the year 2013 as most of the records were missing.

Chart 5: Statistics for the 1st quarter of 2014

ICU Mortality for the 1st quarter of 2014 = 20.6%
Chart 6: Admission by speciality for the 1st quarter of 2014:

Harare Central Hospital (HCH) Intensive Care Unit

The ICU at HCH has maximum capacity of 4 beds and 4 HDU beds. It normally accommodates four ventilated patients and when pressure of beds arises, can accommodate up to 5 ventilated patients.

Staff Establishment

The unit has a dedicated consultant anaesthetist and a registrar in charge during normal working hours on weekdays, after this the consultant and registrar on call in theatre take over management of patients in the unit, together with the SHO or Senior Resident Medical Officer (SRMO) on call.
There are 2 senior intensive care trained nurses in charge of this unit, together with 8 intensive care nurses and 12 registered general nurses and student nurses who rotate during their training. There are 2 general hands and 1 cleaner.

Below are charts showing patients statistic at HCH ICU showing number of patients on the vertical axis and time on the horizontal axis.

**Chart 7: HCH Statistics for the year 2012**

ICU mortality for the year 2012= 35.9%
Chart 8: Shows annual statistics for the year 2013

ICU mortality for the year 2013 = 28.3%

Chart 9: Statistics for the 1st quarter of 2014 including April
ICU mortality for the months January-April 2014 = 29.6%

**Outcome indices in ICU**

Intensive Care Units have the highest mortality in hospitals, with rates averaging about 8 – 19% of the ICU in-patients or 500 000 deaths annually in the United States \(^3-5\). Various other indices have been used to assess outcomes of patients admitted into ICU.

Outcome measures are important for research, quality control, and comparing performances of different ICUs. Clinically important outcomes also measure how patients feel, function or survive; e.g. mortality and quality of life after discharge. Surrogate outcomes are a substitute that would be expected to be beneficial based on epidemiological, physiological or other scientific grounds and unless validated should not be used to change clinical practice. Other outcome measures which have been used include length of stay in ICU, readmission into ICU, unplanned admission and interventions including length of respiratory support, and renal replacement therapy.

In this study the primary outcomes being investigated were mortality and length of admission in the ICU. As an outcome measure, mortality was chosen in this study because of some of its advantages. Firstly, death is an important endpoint. It is a simple, single metric which can be obtained readily available in the hospital database. The aggregation of a large number of diagnoses with a small power in each, over time may increase the power to detect variation. And variation seen over time may reflect institutional and organisational events or characteristics like bed pressure and staff shortages, and this can help to detect deficiencies. Mortality can also be used when combined as part of a quality program. However, there are
some disadvantages of using mortality as an outcome measure; firstly the definition of ICU is very hospital specific which can influence mortality (e.g. non-ICU step-down areas in some hospitals). There may be poor correlation between mortality and quality of care in some diagnoses and alternatives have been made available e.g. diagnosis specific risk models such as the European System for Cardiac Operative Risk Evaluation (EuroSCORE) for Coronary Artery Bypass Graft (CABG), Acute Physiology and Chronic Health Evaluation (APACHE), Standardized Mortality Ratio (SMR) and various trauma scores which will be briefly discussed below. The use of mortality can also mask problems in low volume diagnostic groups. It is difficult to draw hospital comparisons and or allow league table construction and false conclusions can be drawn unless robust statistical methods are applied in studies.

**Severity Scoring Systems used in critically ill patients.**

Various factors have been shown to increase the risk of adverse outcomes in ICU patients and scoring systems were developed from the 1980s which allow the assessment of the severity of a condition and an estimate of in-hospital mortality. Comparison of different units and their outcomes is also a feature of scoring systems. The factors include severity of acute illness, co morbidities (malignancy, immunosuppression, and renal failure), emergency admission etc. Several scoring systems have since been developed and are usually known by their acronyms (e.g. NEWS, APACHE).

These systems can either be based on a physiologically based scoring system or a diagnosis based scoring system. Physiological based scoring systems are applied to critically ill patients. These patients usually have at least one organ system failure and therefore cannot get into
any particular diagnostic group and it is therefore more applicable to this group of patients compared to a diagnosis based scoring system. The scoring system consist of two parts, a calculated probability of mortality and a severity score, which is a number and the higher the number, the higher the severity of illness is \(^7,8\). Predicament of outcome can be based on these scores and also allocation of resources in the ICU. The different systems need to be updated as new therapeutic diagnostic and prognostic techniques are being invented in ICU.

The ideal scoring system

The Ideal Scoring system should have the following characteristics.

1. Based on easily/routinely recordable variables.
2. Well calibrated system.
3. The ability to predict functional status or quality of life after ICU discharge.
4. Used in different patient populations.
5. Used in different countries
6. A high level of discrimination

There is no scoring system which has all the above features

Outcome Prediction Scores

Acute Physiology and Chronic Health Evaluation (APACHE)

This was developed in 1981, to group patients according to the severity of illness. This is divided into two sections, a physiological score which assessed severity of acute illness and a preadmission evaluation which determines the chronic health status of a patient \(^9\). The
original model was revised into the APACHE II in 1985, and this modelled just 12 different physiological variables, compared with 35 which were in the original APACHE\textsuperscript{9,10}. The APACHE III was developed in 1991 and validated in 1998 and most recently, the APACHE IV was developed. The APACHE II score is widely used and is measured in the first 24 hours after admission. It is not calculated during the stay because it is an admission score and if a patient is discharged from ICU and readmitted, a new score is calculated\textsuperscript{8}. Below is a table for the APACHE II.

Table 1 APACHE II scoring system

<table>
<thead>
<tr>
<th>Physiologic Variable</th>
<th>High Abnormal Range</th>
<th>Low Abnormal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature - rectal (°C)</strong></td>
<td>≥41°</td>
<td>39 to 40.9°</td>
</tr>
<tr>
<td></td>
<td>38.5 to 38.9°</td>
<td>36 to 38.4°</td>
</tr>
<tr>
<td></td>
<td>34 to 35.9°</td>
<td>32 to 33.8°</td>
</tr>
<tr>
<td></td>
<td>30 to 31.9°</td>
<td>≤29.9°</td>
</tr>
<tr>
<td><strong>Mean Arterial Pressure - mm Hg</strong></td>
<td>≥160</td>
<td>130 to 149</td>
</tr>
<tr>
<td></td>
<td>120 to 129</td>
<td>110 to 119</td>
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<tr>
<td></td>
<td>100 to 109</td>
<td>90 to 99</td>
</tr>
<tr>
<td></td>
<td>≤89</td>
<td>≤79</td>
</tr>
<tr>
<td><strong>Heart Rate (ventricular response)</strong></td>
<td>≥180</td>
<td>160 to 179</td>
</tr>
<tr>
<td></td>
<td>150 to 159</td>
<td>140 to 149</td>
</tr>
<tr>
<td></td>
<td>130 to 129</td>
<td>120 to 119</td>
</tr>
<tr>
<td></td>
<td>≤110</td>
<td>≤90</td>
</tr>
<tr>
<td><strong>Respiratory Rate (non-ventilated or ventilated)</strong></td>
<td>≥50</td>
<td>45 to 49</td>
</tr>
<tr>
<td></td>
<td>44 to 43</td>
<td>42 to 41</td>
</tr>
<tr>
<td></td>
<td>40 to 39</td>
<td>38 to 37</td>
</tr>
<tr>
<td></td>
<td>≤36</td>
<td>≤30</td>
</tr>
<tr>
<td><strong>Oxygenation: A-aDO\textsubscript{2} or PaO\textsubscript{2} (mm Hg)</strong></td>
<td>a. FIO\textsubscript{2} ≥0.5 record A-aDO\textsubscript{2}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥150</td>
<td>130 to 149</td>
</tr>
<tr>
<td></td>
<td>120 to 119</td>
<td>100 to 109</td>
</tr>
<tr>
<td></td>
<td>90 to 99</td>
<td>80 to 89</td>
</tr>
<tr>
<td></td>
<td>≤79</td>
<td>≤70</td>
</tr>
<tr>
<td></td>
<td>b. FIO\textsubscript{2} &lt;0.5 record PaO\textsubscript{2}</td>
<td>PO\textsubscript{2}</td>
</tr>
<tr>
<td></td>
<td>PO\textsubscript{2} 61 to 70</td>
<td>PO\textsubscript{2} 51 to 60</td>
</tr>
<tr>
<td><strong>Arterial pH (preferred)</strong></td>
<td>≥7.7</td>
<td>7.6 to 7.69</td>
</tr>
<tr>
<td></td>
<td>7.5 to 7.59</td>
<td>7.4 to 7.49</td>
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<tr>
<td></td>
<td>7.3 to 7.33</td>
<td>7.2 to 7.24</td>
</tr>
<tr>
<td></td>
<td>≤7.15</td>
<td>≤7.15</td>
</tr>
<tr>
<td><strong>Serum HCO\textsubscript{3} (venous mEq/l) (not preferred, but may use if no ABG)</strong></td>
<td>≥52</td>
<td>41 to 51.9</td>
</tr>
<tr>
<td></td>
<td>32 to 40.9</td>
<td>22 to 31.9</td>
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<td></td>
<td>18 to 22.9</td>
<td>13 to 19.8</td>
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<tr>
<td></td>
<td>≤15</td>
<td>≤15</td>
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<tr>
<td><strong>Serum Sodium (mEq/l)</strong></td>
<td>≥160</td>
<td>155 to 162</td>
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<td>150 to 159</td>
<td>145 to 154</td>
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<td>140 to 149</td>
<td>135 to 143</td>
</tr>
<tr>
<td></td>
<td>≤130</td>
<td>≤129</td>
</tr>
<tr>
<td><strong>Serum Potassium (mEq/l)</strong></td>
<td>≥7</td>
<td>6 to 6.9</td>
</tr>
<tr>
<td></td>
<td>5.5 to 5.9</td>
<td>5.5 to 5.4</td>
</tr>
<tr>
<td></td>
<td>3 to 3.4</td>
<td>2.5 to 2.9</td>
</tr>
<tr>
<td></td>
<td>≤2.5</td>
<td>≤2.5</td>
</tr>
<tr>
<td><strong>Serum Creatinine (mg/dl) Double point score for acute renal failure</strong></td>
<td>≥3.5</td>
<td>3.4 to 3.4</td>
</tr>
<tr>
<td></td>
<td>1.5 to 1.9</td>
<td>0.6 to 1.4</td>
</tr>
<tr>
<td></td>
<td>≤0.6</td>
<td>≤0.6</td>
</tr>
<tr>
<td><strong>Hematocrit (%)</strong></td>
<td>≥60</td>
<td>50 to 59.9</td>
</tr>
<tr>
<td></td>
<td>46 to 49.9</td>
<td>43 to 45.9</td>
</tr>
<tr>
<td></td>
<td>40 to 42.9</td>
<td>37 to 39.9</td>
</tr>
<tr>
<td></td>
<td>≤20</td>
<td>≤20</td>
</tr>
<tr>
<td><strong>White Blood Count (total/mm\textsuperscript{3}) (×10\textsuperscript{3})</strong></td>
<td>≥40</td>
<td>35.9 to 39.9</td>
</tr>
<tr>
<td></td>
<td>30 to 34.9</td>
<td>25 to 29.9</td>
</tr>
<tr>
<td></td>
<td>≤24</td>
<td>≤24</td>
</tr>
<tr>
<td><strong>Glasgow Coma Score (GCS)</strong></td>
<td>Score = 15 minus actual GCS</td>
<td>A. Total Acute Physiology Score (sum of 12 above points)</td>
</tr>
<tr>
<td></td>
<td>B. Age points (years) ≤44=0; 45 to 54=2; 55 to 64=3; 65 to 74=5; ≥75=6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. Chronic Health Points (see below)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total APACHE II Score (add together the points from A+B+C)</td>
<td></td>
</tr>
</tbody>
</table>

(Adapted from www.medicalcriteria.com)
Chronic Health Points: If the patient has a history of severe organ system insufficiency or is immune-compromised as defined below, assign points as follows:

- 5 points for non-operative or emergency postoperative patients
- 2 points for elective postoperative patients

Definitions: organ insufficiency or immune-compromised state must have been evident prior to this hospital admission and conform to the following criteria:

Liver – biopsy proven cirrhosis and documented portal hypertension; episodes of past upper GI bleeding attributed to portal hypertension; or prior episodes of hepatic failure/encephalopathy/coma.

Cardiovascular – New York Heart Association Class IV.

Respiratory – Chronic restrictive, obstructive, or vascular disease resulting in severe exercise restriction (i.e., unable to climb stairs or perform household duties; or documented chronic hypoxia, hypercapnia, secondary polycythemia, severe pulmonary hypertension (>40 mmHg), or respirator dependency.

Renal – receiving chronic dialysis.

Immune-compromised – the patient has received therapy that suppresses resistance to infection (e.g., immunosuppression, chemotherapy, radiation, long term or recent high dose steroids, or has a disease that is sufficiently advanced to suppress resistance to infection, e.g., leukemia, lymphoma, AIDS).
**Simplified Acute Physiology Score (SAPS)**

The SAPS is a severity of illness classification system, designed to measure severity of illness in ICU patients who are at least 15 years of age. Like the APACHE score system it is an admission score which is measured within the first 24 hours of admission. SAPS was first released in France in 1984 as an alternative to the APACHE score system and originally assessed 14 physiological variables which are measured within the first 24 hours of admission. No input was put on pre-existing disease. In 1993, Le Gal and associates used statistical regression analysis to develop SAPS2 system. This model uses 17 variables: 12 physiological variables, age, type of admission (non-operative and emergency/elective surgery) and 3 chronic diagnoses (AIDS, metastatic cancer and haematological cancers). The diagram below shows the variables collected in the SAPS2 system.
Table 2: Simplified Acute Physiology Score 2

![SAPSIIFigure]

(Adapted from JAMA 1993; 270(24):2957-2963)

Simplified Acute Physiology Score 3 (SAPS 3) was the first critical care prognostic model developed from worldwide data. The SAPS 3 was developed in 2002 and the scores used in this model are based on data collected within the first hour of admission into ICU. It allows prediction of outcomes before ICU interventions occur, and better evaluation of an individual patient rather than performance of an ICU.
Mortality Prediction/Probability Model (MPM)

This system allows calculation of the probability of hospital death to be made, rather than a severity score which needs to be converted. The first model used 7 variables obtained on admission and repeated at 24 hours. It was later revised and the MPM II was developed which used MPM₀, the admission score containing 15 variables and MPM₂₄, the 24 hour model containing 5 of the admission variables and 8 additional variables. This model is designed for patients staying in ICU for at least 24 hours. The MPM III has been updated from MPM₀, and is widely used in North America. It utilises 16 variables, including 3 physiological parameter obtained within an hour from admission. This method has been shown to be more accurate in predicting length of stay (LOS) in ICU.

Sepsis related organ failure assessment (SOFA)

Sepsis related Organ Failure Assessment (SOFA) was developed by the European Society of Intensive Care Medicine in order to assess the severity of organ dysfunction associated with sepsis although it has been validated to other patient groups with organ dysfunction not due to sepsis. 6 organ systems are weighted (each with a score of 1-4) giving a total score range of 6-24. These include respiratory, cardiovascular, central nervous system, renal, coagulation and the hepatic systems.
Table 3: Sepsis related Organ Failure Assessment

<table>
<thead>
<tr>
<th>SOFA score</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{PaO}_2/\text{FiO}_2$, mmHg</td>
<td>$&lt;400$</td>
<td>$&lt;300$</td>
<td>$&lt;200$</td>
<td>$&lt;100$</td>
</tr>
<tr>
<td><em>with respiratory support</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Coagulation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platelets $\times 10^3$/mm$^3$</td>
<td>$&lt;150$</td>
<td>$&lt;100$</td>
<td>$&lt;50$</td>
<td>$&lt;20$</td>
</tr>
<tr>
<td><strong>Liver</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilirubin, mg/dl (umol/l)</td>
<td>$1.2-1.9$</td>
<td>$2.0-5.9$</td>
<td>$6.0-11.9$</td>
<td>$&gt;12.0$</td>
</tr>
<tr>
<td>(20-32)</td>
<td>(33-101)</td>
<td>(102-204)</td>
<td>(&lt;204)</td>
<td></td>
</tr>
<tr>
<td><strong>Cardiovascular Hypotension</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAP $&lt;70$ mmHg</td>
<td>Dopamine $\leq 5$ or dobutamine (any dose)$^a$</td>
<td>Dopamine $&gt;5$ or epinephrine $\leq 0.1$ or norepinephrine $\leq 0.1$</td>
<td>Dopamine $&gt;15$ or epinephrine $&gt;0.1$ or norepinephrine $&gt;0.1$</td>
<td></td>
</tr>
<tr>
<td><strong>Central nervous system</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glasgow Coma Score</td>
<td>$13-14$</td>
<td>$10-12$</td>
<td>$6-9$</td>
<td>$&lt;6$</td>
</tr>
<tr>
<td><strong>Renal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creatinine, mg/dl (umol/l) or urine output</td>
<td>$1.2-1.9$</td>
<td>$2.0-3.4$</td>
<td>$3.5-4.9$</td>
<td>$&gt;5.0$</td>
</tr>
<tr>
<td>(110-170)</td>
<td>(171-299)</td>
<td>(300-440)</td>
<td>(&gt;440)</td>
<td></td>
</tr>
<tr>
<td>or $&lt;300$ ml/day or $&lt;200$ ml/day</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^a$ Adrenergic agents administered for at least 1 h (doses given are in μg/kg/min)

(Adapted from Intensive Care Medicine. (1996) 22: 707-710.)

Multiple Organ Dysfunction Scores (MODS)

This system scores 6 organ systems, the cardiovascular, renal, respiratory, central nervous, hepatic and haematological systems and each is awarded scores ranging from 0-4. It allows a day by day prediction for patients and correlates strongly with risk of ICU and hospital mortality, it is also available to therapeutic manipulation.$^8,13$

National Early Warning Score (NEWS)

Early warning scores are based on the principle that clinical deterioration of a patient can be detected in multiple physiological measurements, as well as large changes within a single variable. The National Early Warning Score is a simple scoring system allocating a score to
physiological variables which are already present when the patient presents to hospital. The parameters include:

1. Respiratory rate
2. Oxygen Saturation
3. Temperature
4. Systolic blood pressure
5. Pulse rate
6. Level of consciousness

The system can offer an enhanced level of surveillance and review of patients with greater specificity in identifying the risk of clinical detection in patient. The Royal College of Physicians recommends the use of NEWS to standardize assessment and scoring of simple physiological parameters. The parameters are simple and easy to assess and do not require many resources.
Table 4: The NEWS table

<table>
<thead>
<tr>
<th>SCORE PARAMETER</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESPIRATORY RATE</td>
<td>≤8</td>
<td>9-11</td>
<td>12-20</td>
<td>21-24</td>
<td>≥25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OXYGEN SATURATION (%)</td>
<td>≤91</td>
<td>92-93</td>
<td>94-95</td>
<td>≥96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANY SUPPLEMENTARY OXYGEN</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEMPERATURE(°C)</td>
<td>≤35.0</td>
<td>35.1-36.0</td>
<td>36.1-38</td>
<td>38.1-39</td>
<td>≥39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTOLIC BLOOD PRESSURE</td>
<td>≤90</td>
<td>91-100</td>
<td>101-110</td>
<td>111-219</td>
<td>≥220</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEART RATE</td>
<td>≤40</td>
<td>41-50</td>
<td>51-90</td>
<td>91-110</td>
<td>111-130</td>
<td>≥131</td>
<td></td>
</tr>
<tr>
<td>LEVEL OF CONSCIOUSNESS</td>
<td></td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

KEY: V-Response to Verbal command, P-Response to Pain, A-Alert, U-Unconscious

When the individual scores are measured, they are added up and the final score obtained and put in the table below.

Table 5: NEWS scale

<table>
<thead>
<tr>
<th>SCORE</th>
<th>CLINICAL RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>LOW</td>
</tr>
<tr>
<td>1-4</td>
<td>LOW</td>
</tr>
<tr>
<td>RED SCORE(*INDIVIDUAL PARAMETER OF 3)</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>5-6</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>≥7</td>
<td>HIGH</td>
</tr>
</tbody>
</table>
Evidently this is an easy way of assessing patient physiological status and can be easily implemented in the ward and measured by the nursing staff in the general ward. However, it cannot be used in patients below the age of 16 years and pregnant women because of the difference in physiological changes in response to illness.

**Limitations of severity Scores**

The severity scores have limited value in an individual patient but allow for comparison of different ICUs. They are not accurate in predicting mortality for some diagnoses. With new therapeutic, diagnostic and prognostic technology, the scoring systems need to be updated as they lose calibration over time\textsuperscript{11,12}.

Assessment of disease severity and organ dysfunction, resource allocation and outcome prediction can be done using general illness severity scores in the ICU. At present, severity scoring systems are not frequently used at Parirenyatwa and Harare Hospitals except for scores like the Glasgow Coma Scale (GCS), making it difficult to assess resource use and prediction of outcome of our patients.

**Measures developed in attempt to reduce ICU morbidity and mortality**

To improve outcome of patients admitted into ICU, various steps have been taken in different centres worldwide, these include the following:

Critical Care Medicine (CCM) has become a separate sub-speciality since \textsuperscript{1}, allowing more aggressive and dedicated management of patients by a specialised team of intensivists.
Nowadays the sub-speciality is not just limited to anaesthesiologists but to different disciplines e.g., surgeons and physicians.

The development of specialised ICUs (e.g. Neuro-ICU, Cardio-ICU) in some countries improves patient outcome. After several reports which showed sub-optimal management of patients who had been discharged from the ICU and general ward patients who deteriorated, critical care outreach teams have been formed as a strategy to deliver critical care services outside of the ICU in countries like England and Wales. This usually consists of 5 senior Intensive Care nurses led by a Consultant nurse, who visit patients that have been discharged from ICU. Interventions carried by the critical care outreach team include the following:

- Guiding tracheostomy management.
- Performing tracheal and chest physiotherapy.
- Guiding management of continuous positive airways pressure.
- Optimising patient position
- Requesting nebuliser and/or administration of nebuliser therapy
- Repeat blood testing full blood count, renal function tests
- Fluid balance monitoring

After the introduction of outreach teams, a reduction in ICU re-admissions and patient survival up to discharge from the Hospital has been demonstrated.

The formation of Rapid Response Teams (RRT) or Medical Emergency Teams (METs) has been implemented in developed countries and their role is to quickly deliver high care in critically ill patients who are located outside of the ICU. It consists of any of the following staff:
- Physician – Hospital or Intensive or a Senior Resistant
- Physician Assistant
- Critical Care Nurse
- Clinical Nurse Specialist
- Respiratory Therapist

The RRT must have dedicated personnel and must be able to respond immediately when called, be on site and easily accessible and must have critical care skills. The use of METs has been very effective, reducing 50% cardiac arrest incidence outside ICU\textsuperscript{14}, and a reduction in emergency ICU admissions by 44% \textsuperscript{15}. Mean duration of hospital stay and adverse post operative events were also reduced \textsuperscript{14-16}.

Inter-hospital and in-hospital transfer of critically ill patients has been recognised to be associated with morbidity and mortality\textsuperscript{18}. Sources of adverse events can be due to either mishaps which are related to intensive care e.g. lead disconnections, accidental extubation, battery loss, oxygen failure etc and can also be due to physiological deterioration of the patient secondary to their illness e.g. hypotension, hypoglycaemia, hypoxia etc.

Recommendations by the American Academy of Paediatrics includes transport of patients by physicians with a higher level of training (at least 3\textsuperscript{rd} year residency) \textsuperscript{18,19} to try to minimise adverse outcomes.

**Setup of an Ideal Intensive Care Unit**

ICUs are usually in one locality of the hospital. They may be general or specialised. Specialised ICUs may be located within their discipline e.g. Cardiothoracic ICU may be located
in the Cardiothoracic Surgery Department. They have the following major characteristics: space, specialised equipment and staff, continuous service and 24 hour monitoring of cardiovascular, respiratory renal and nervous system status and a separate ventilator capable of continuously working on one patient until recovery from the illness\(^1\).

**Location**

For clinical reasons, the ICU should be easily accessible to the departments from which patients are usually admitted, e.g. the emergency department and operating theatres. It is also desirable for the unit to be located near radiological services and laboratory services so that there is minimal patient movement\(^1\).

**Size**

The number of ICU beds per hospital depends on the number of total hospital beds per hospital and the occupancy of the unit. The Health Building Note 27 (HBN27) is a planning guide used in the UK as the main planning guide which has been applied and intended to define minimum ICU requirements. It recommends that an estimated 12% of the number of hospital beds should be allocated for Intensive Care unit. Occupancy, which is defined as Patient Days divided by average inventory bed days in reporting period, should have an average of 60-70%, therefore units which run with occupancies of more than 70% are too small and those less than 60% are too large and require less beds. ICUs should be able to accept 95% of all appropriate emergency referrals for admission.
The Intensive Care Unit, recovery room and High dependency Units have got differing patterns of work and are not similar.

Staff

Having adequate highly skilled staff is necessary for a fully functional, effective ICU. The HBN27 recommends a designated consultant to bear the administrative responsibility for the unit. Critical Care Medicine should be consultant-led at all times. The Royal College of Anaesthetists and Critical Care Society recommend that all ICUs with at least four beds should have a consultant without other commitments covering during each weekday.

The intensive care resident/registrar should have no other commitments and be responsible only for the ICU. All decisions about patient care should involve the resident and responsibility is continuous throughout the 24-hour day.

According to the Guidelines on Admission to and Discharge from Intensive Care and High Dependency Units, ICU nurse to patient ratio should be 1:1, although this has to be applied realistically to different ICUs. At times, some patients might not require the undivided attention of one nurse, e.g. a patient who has been extubated and not requiring organ support and awaiting discharge. On the other hand, patients who might require mechanical ventilation and haemodialysis may require two or more nurses.

A senior nurse with several years experience and an appropriate level of qualification should be in charge and be assisted by other senior trained nursing staff. Post registration education in ICU nursing is the desired qualification needed for nursing staff but has to be assessed for a
particular unit. Other relevant personnel in the ICU include physiotherapists, radiographers, dieticians, pharmacists, clerical support, cleaning staff, and laboratory scientists.

**Costs**

Running an Intensive Care Unit is very costly as the treatments are very expensive and labour intensive. The type of equipment used in the intensive care unit is very sophisticated and requires a lot of consumables to function e.g. mechanical ventilators, monitors, etc. Accurate assessment of the costs incurred in an ICU remains a challenge as the methodology to determine it remains controversial \(^{20}\).

Mechanical ventilation of patients is associated with significantly higher daily costs \(^{20}\) and reducing the duration of mechanical ventilation in patients can lead to reduction in total inpatient cost.

An exponential increase in ICU costs has occurred from 1985 to 2000 in the United States and take up 20-30\% of all hospital costs \(^{20,21}\), accounting for 10\% of all inpatient beds and take out 1 out of every 3 dollars spent.

The Society of Critical Care Medicine (SCCM) is an organisation representing nearly 16 000 professionals in more than 100 countries working in the ICUs. According to the SCCM, in the USA, between 2000 and 2005, costs in the departments of Critical Care Medicine increased from $55, 6 - $81,7 billion, about 13,4\% of hospital costs. This has been partly attributed to the increasing elderly population and sepsis related ailments in this age group. The average cost per patient /day ranges from $858 – 1,185 in the United Kingdom \(^{15}\).
Reducing length of ICU stay and days on mechanical ventilator help reduce the costs incurred by hospitals. Interventions have been implemented which include triaging patients, goal directed therapy e.g. in management of sepsis, and the presence of ICU staff providing continuous monitoring of patients. These measures help to reduce costs and become important in environments which have limited resources.

Delays in the appropriate delivery of care have a negative impact on a variety of both medical and surgical conditions. The “Golden hour” of trauma, “Early goal directed therapy” in the management of septic shock and ‘Door to balloon time’ in acute myocardial infarction have all been shown to have an association with delay and patient outcome. With the need for ICU/HDU facilities being exceeded by their availability in many centres worldwide, timely definitive management may be a challenge. Various factors account for this shortage in the availability of facilities including shortages of highly trained nursing staff, specialist physicians, and the high cost of running this type of a facility. Medical Emergency Teams (METs) have been adopted which take care of critically ill patients outside the ICU. Beds, staff, equipment and also the very high cost of running an ICU, in the USA, ICU/HDU account for 10% of inpatient beds and cost 15-20% inpatient costs as noted above. In resource limited regions like Zimbabwe a combination of these factors contribute to lack of bed availability and possible delay of patient admission into ICU.

Studies have been done on delayed admissions to ICU/HDU with different end point measurements. Delayed admission from the Emergency department into ICU has been shown to lead to prolonged inpatient hospital stay and cost and has higher requirements for advanced ventilator support and prolonged ventilation time. Successful management of
critically ill patients requires a multi-disciplinary approach from specialised personnel, e.g. (intensive care physicians and nurses), specialised equipment, time and medication, and these resources may not be available in the general ward or emergency department. Therefore, it would be ideal for patients to be admitted from their departments of referral directly into the ICU as some studies demonstrated a higher mortality in patients admitted from the emergency department to a general ward then ICU than patients admitted directly to ICU. ICU delay time has also been associated with a greater mortality risk in critically ill medical patients requiring mechanical ventilation and renal replacement therapy.
Statement of the problem

Aim of study

In critical care medicine, the successful management of patients requires early recognition of physiological and clinical deterioration followed by prompt adequate and appropriate intervention; therefore institution of definitive management of critically ill patients is time critical. The appropriate level of care is offered in an ICU setup where resources (human and equipment) are present. However, at Parirenyatwa and Harare hospitals there are reports of unavailability of nursing staff, equipment e.g. functioning ventilators and this has resulted at times in boarding of critically ill patients in the Emergency Department, theatre recovery room and general wards whilst awaiting ICU admission. The aim of this study is to determine if the time taken between referral of a patient to ICU until admission has any adverse impact in terms of the duration a patient stays in ICU and the mortality.

Research questions

- What is the duration of time from referral to admission to ICU?
- Is there a difference in Length of stay between early and late admission?
- What is the mortality in Parirenyatwa/Harare ICUs?

Main Objective

To determine the correlation between time taken to admission into the intensive care unit with length of stay and mortality.
Other objectives

To determine the average time taken from the point referral to admission at Parirenyatwa and Harare hospitals.

Methodology

1. Approval of Study

The study was approved by the Joint Parirenyatwa Hospital and College of health Science Research Ethics Committee (JREC) (see appendix 1). No patient was prejudiced on religious, political, cultural, social or educational grounds.

2. Study population

Adult emergency patients admitted into the intensive care and High dependency unit were included in the study.

Inclusion criteria

- Emergency adult medical and surgical patients

Exclusion criteria

- Relative refusal to consent
- Elective ICU and HDU admissions
- Paediatric patients
- Inter-hospital transfer of ICU or HDU patients
3. **Setting**

The study was carried out at Parirenyatwa group of hospitals and Harare central hospital, ICUs both of which are tertiary teaching institutions.

4. **Design**

A Prospective descriptive study was carried out at the two above mentioned hospitals by the primary researcher and 2 research assistants. They would either regularly enquire or be informed by the on-duty intensivist/anaesthetist and nursing staff of any patients who had been referred to ICU for admission. Patients who fitted the inclusion criteria were enrolled into the study after consent was obtained from relatives. The main data collected included the time and date of referral, and time and date of admission into ICU from the nursing chart.

A follow up of the patients was then done up to discharge from the ICU/HDU or up to death of the patient. Other data collected is shown on the Data Sheet (Appendix 4).

5. **Sample size**

Using the formula $N = \frac{P \times (100\% - P)}{(SE)^2}$

$SE$- standard error = 2.55 (Based on 95% Confidence Interval)

$P$ – Proportion of patients who are admitted late into the ICU/HDU

$Z = 1.96$ (Used to calculate SE)

$N = 139$
6. **Data collection**

Data was entered on a data collection sheet (see appendix 4)

7. **Ethical considerations**

Patients who were able to consent for the study were counselled in the language they understood and upon agreement were enrolled. For patients who were unable to give consent e.g. neurosurgical patient, their next of kin was counselled on the objectives of the study, the potential risks and benefits for joining the study. A consent form written in English and vernacular with the above explanations was given to the patient’s next of kin to read and sign indicating Informed consent.
Results and analysis

The study was undertaken at Parirenyatwa and Harare central hospitals during the period from February 2014 to May 2014. A total of 128 emergency medical and surgical patients were included in the study. Figure (5) shows the age distribution of the study participants. The average age of the participants was 34.17 years with a standard deviation of 14.8 years.

Figure 1: Age distribution of the study participants

Figure 1 and figure 2 shows the different age distribution of the participants, the majority of patients were in the young age groups (making up 15% of patients below the age of 19 and 51.8% aged between 20-35 years of age). The middle aged to elderly patients makes up less of the ICU patient population (28.9% of patient aged between 36-65 years and 5.3% aged at least 65 years).

Figure 1: Age distribution of patients
Out of 128 patients 43.0% were males and 57.0% were females.
Chart 10: Patient categories by speciality

- General Surgery: 36%
- Neurosurgery: 17%
- Obstetric and Gynaecology: 20%
- Medical: 16%
- Polytrauma/Orthopaedics/Cardiothoracic: 11%

Chart 11: Reasons for admission delay

- Theatre delay: 36%
- No ICU bed: 37%
- No ICU nurse: 16%
- No ventilator: 5%
- Delay in review: 6%
Figure 4: Shows the number of delayed and non-delayed patients

- Average delay was 7.5 hours (Standard Deviation=13.7 hours), 95% Confidence interval for mean was 5.1 - 10.0 hours.
- 52.0% were admitted within 4 hours from referral and 48% were admitted at least 4 hours after referral was made.
- The proportion of males delayed for more than 4 hours (63.0%, N=54) was significantly higher than their female counterparts (36.2%, N=69). The analysis shows that most females (63.8%, N=69) were admitted into the ICU within 4 hours of referral as compared to 37.0% (N=54) males. \textit{P-value = 0.003}
Patients who were delayed for more than 4 hours were more likely to die as compared to those who were delayed for less than four hours. Figure above shows that of the patients who were delayed for more than 4 hours 22.9% died while 18.3% died for patients delayed by 4 hours. However this was not statistically significant, $P$-value=0.634.
On average the patients admitted into the ICU were staying for approximately 4 days (standard deviation (5 days and inter quartile range (6 days). At most half the patients stayed for 3 days.

On average patients delayed for admission by ≤4 hours spent 4 days while patients delayed by more than 4 hours spent about 5 days. The difference in the number of days spent in the ICU was not statistically significant when delay duration of ≤4 and > 4 hours was considered, p=0.083. Thus, the number of days spent in the ICU was not determined by delay duration in this study.
Discussion

In the present study, the results showed that delay is a common occurrence and had no association with length of ICU stay and increased mortality. However the proportion of male patients admitted after a delay of at least 4 hours was higher than that of female patients and was statistically significant.

Early recognition is the first step towards early intervention, and timely institution of definitive management in a critically ill patient influences clinical outcomes. Guidelines such as Early Goal Directed Therapy in management of sepsis and Door-To-Balloon Time in management of ST-segment elevation myocardial infarction emphasize on the importance of time for improved mortality.

Critically ill patients need intensive and longitudinal care from a multi-disciplinary team. General wards, emergency department and the theatre recovery room are all locations within the hospital where critically ill patients have been kept pending admission into ICU, but these do not offer the standard of intensive care offered in ICU. Reasons may include lack of specialised staff (ICNs, critical care physicians etc) and inadequate nurse to patient ratio, therefore the care provided in these locations cannot replace that in the ICU. Patients will have a better outcome and reduced LOS in the Hospital when they are treated in ICU with critical care physicians and a good nurse to patient ratio so for the purposes of this study, patients who were boarded in the theatre recovery room and emergency department were considered to have been delayed in the methodology.
The present study classified patients into delayed and non-delayed groups by using a cut-off of 4 hours. The dividing line between ‘delayed’ and ‘non-delayed’ was proposed as the time when the effect of ICU waiting on mortality started to emerge, and based on a number of studies, mortality increased in patients who had an ICU waiting time of at least 4 hours. Peter J. Kaboli et al demonstrated a 5-fold higher adjusted risk of death in patients transferred at 4 hours after a marker a clinical stability was first noted compared to those transferred earlier. There has been no definition of the ideal time from referral to admission (lead time), as different studies have used varying cut offs for defining delay and non delay. Therefore the emphasis is on immediate admission once a patient is a candidate for ICU care.

In the study, the proportion of patients with a delay from referral to admission of more than 4 hours was 48%. When compared to other studies which have been done in Hong Kong, Israel, France and England and showed delay time frequencies of 37.8%, 24-56.5%, 27.6% and 32.6% respectively. Reasons for the delay noted varied with the most commonly encountered being unavailability of a free ICU bed, which may indicate a high ICU occupancy rate. Other reasons included shortage of nursing staff therefore in those cases; transfer had to be delayed whilst an extra nurse was being looked for. In emergency surgical patients who had to go via theatre prior to admission, another cause of delay was the time taken during initially optimisation in preparation for theatre and also delay in being taken to theatre due to the emergency-on-call team having too many patients to anaesthetise.

The mean lead time was 7.5 hours with a standard deviation of 13.7 hours. The confidence interval for the mean was 5.1-10.0 hours. The proportion of male patients admitted after a delay of more than 4 hours was 63% and was significantly higher than that for females which
was 36%, p-value=0.003. This could be explained by the conditions encountered in the study involving female patients for example post partum haemorrhage, hypertensive disorders of pregnancy which generally have a shorter response time when it comes to intervention and require less time for optimisation because they are usually taken to theatre promptly. Not all emergency patients are taken to theatre immediately, as some need surgery as soon as possible e.g., intra-abdominal haemorrhage etc and in this subgroup the time taken from presentation, referral, surgery and admission to intensive care is generally shorter. Patients with generalised peritonitis might benefit from a brief period of physiological stabilisation e.g. correction of dehydration and electrolyte imbalances.

In the present study, patients admitted within 4 hours of referral had 18.3% mortality compared to those delayed by more than 4 hours who had a mortality of 22.9%. However this difference was not statistically significant, p-value=0.634. In terms of length of stay in ICU, delayed patients spent an average of 5 days while the non-delayed group spent 4 days. Thus the number of days spent was not statistically significant when time to admission was considered. Some similar studies done investigating the effect of ICU waiting time on mortality and length of stay showed an increased mortality rate and length of stay in patients who had delayed admission. While physiologic deterioration in some patients can be unpredictable and sudden, as with massive pulmonary embolism or ventricular fibrillation, deterioration is often more gradual and insidious, as typically seen in respiratory insufficiency or sepsis. Other studies did not show an increased length of stay or mortality in delayed patients. ICU admission has been seen as a surrogate of time to definitive treatment of critically ill patients, but the fundamental factors that affect outcome are likely to include
specific interventions and timely organ support, and these do not always require ICU admission and can be initiated at alternate sites, like the Emergency department or theatre recovery room\textsuperscript{25}. This may also be the case at one of the institutions, Parirenyatwa Hospital, where respiratory support can be initiated in the Emergency department resuscitation unit. At both institutions, it is common for surgical patients to be admitted to the theatre recovery room post-operatively and receive organ support whilst waiting for a vacant ICU bed. Delayed admission may have different impacts depending on the main disease of the patient e.g. delayed admission had more adverse effects on patients with pneumonia in one study\textsuperscript{38} and this study was investigating patients admitted in a general ICU with different diagnosis which can also be a factor to the results. With surgical patients making a significant proportion of the study, post-operative outcomes are a result of a complex interplay between exact surgical procedures, previous health of the patient, and specific intra and post-operative events\textsuperscript{39}.

**Conclusion**

A large number of patients admitted into Parirenyatwa and Harare Hospitals are delayed. Delayed admission into ICU of emergency surgical and medical patients does not lead to increased ICU mortality nor does it change the length of stay in this study.

**Study limitations**

The study had several limitations;

1. A small number of patients was enrolled into the study and needed very careful interpretation of the results (Low patient turnout when Parirenyatwa Hospital ICU was
closed due to technical issues between 01/05/15 – 15/05/14 which led to a smaller than calculated sample size).

2. Poor general ward documentation of the dates and times the patient are admitted and also physiological parameters were not documented well in some of the patients.

3. The study was conducted from two academic centres only giving low external validity

4. No outcome prediction score e.g. APACHE II was used in this study due to inconsistent lack of measurement of some variables.

Recommendations

1. Need for adapting a routinely measured severity scores to identify critically ill patients earlier in locations outside the ICU, and use of outcome prediction scores in ICU patients.

2. Improved documentation of patient variables in the ED and general wards, including real time documentation of the variables and critical events.

3. A team of clinicians should be allocated to review patients who might require admission into ICU and HDU. Provisions should be made which allow critically ill patient who were awaiting admission with ICU to be managed e.g. designation of Medical Emergency Teams (METs) which can manage patients outside the ICU. This measure can assist with delays in intensivist review of referred patients.

4. Aggressive ED and theatre recovery room patient management
5. Improved communication with general ward staff for prompt patient discharge to minimize boarding of patients in ICU.
Appendix 2

English consent document

Title of Project: Effect of time taken from referral to Intensive Care Unit admission on mortality, lengthy Intensive Care Unit stay and duration of organ support.

Principal Investigator: DR DAVID PAGWIWA

Study Participant: ________________________________________________________

If you are a parent, guardian, spouse or the legal representative of the study participant, the word “you” in this form refers to the child or adult who will be in the study.

WHY ARE YOU BEING ASKED TO TAKE PART IN THIS RESEARCH?

We are talking to you about this research study because you have been identified as a candidate/relative of the candidate for admission into the Intensive Care Unit or High Dependency Unit. Whether or not you take part in this study is up to you. If you choose not to participate in the study it will not affect the quality of medical care you will receive.

This form gives you important information. Please read it carefully and ask questions before you make a decision. You may want to talk about this research study with your family, your friends, and your other health care providers. Please take your time. You should not sign this form until all of your questions are answered.
WHY IS THIS RESEARCH STUDY BEING DONE?

The purpose of this research study is, to find out what the timing of your admission into the ICU or HDU has on your clinical outcome because you can either be admitted in good time or delayed in your admission due to various reasons.

HOW IS THIS RESEARCH STUDY BEING FUNDED?

This research study will be funded by the department of Anaesthesia and Critical Care Medicine.

HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?

This study will enrol up to 139 people from Parirenyatwa and Harare Central Hospitals.

HOW LONG WILL YOU BE IN THIS STUDY?

Your participation in this research study is expected to last from the 1st of August 2013 to the 30th of June 2014.

Your participation in this study may be stopped if the study doctor thinks (1) it is in your best interest to stop, (2) if you do not follow the study requirements, or (3) or if the study is stopped for any reason.

The study doctor will tell you about new information that might affect your health or could change your decision to be in this study. If this occurs, you may be asked to sign a new consent form.

PARTICIPATION IN THIS STUDY IS VOLUNTARY

Taking part in this study is voluntary. You may choose not to take part or to leave the study at any time. Your decision will not affect your relationship with your doctor or with Parirenyatwa or Harare Central Hospital and will not result in any penalty or loss of benefits to which you are otherwise entitled.
You can stop taking part in this study at any time. Tell the study doctor if you are thinking about stopping or have decided to stop.

If you decide to withdraw your name will be kept anonymous

**WHAT WILL YOU DO IN THIS STUDY?**

In this study we are doing a follow up of your progress. If you are found eligible for this study, you will be placed into one of the study groups of either those who are delayed into ICU/HDU or the non-delayed group.

**WHAT RISKS OR PROBLEMS COULD YOU HAVE BY BEING IN THIS STUDY?**

There are no risks associated with this research.

Risks of Survey Questions: The study includes some questions that may be sensitive or personal. You are free to skip any question for any reason.

**WILL YOU BENEFIT FROM BEING IN THIS STUDY?**

You will not benefit from being in this study. What we learn from this research study may help other people in the future.

**WILL THERE BE ANY COSTS TO YOU?**

Clinical services provided during a research study are either research-related or related to usual medical care. Research-related services are not the responsibility of you or your insurance.

Usual medical care costs include those services that are considered medically necessary to manage your condition. The costs of usual medical care will be your responsibility or your
insurance company and may include deductibles and co-payments. Some insurance companies will not pay for usual medical care if you are participating in a research study. You will not receive any form of payment for participating in this study.

**HOW WILL YOUR PRIVACY BE PROTECTED?**

We will protect your privacy as a participant in this research study and the confidentiality of your research information. The data will be kept in secure records in the Department of Anaesthesia. We may be required by law to report some information (for example; certain infectious diseases, suspected abuse) to a state agency for public health or safety reasons.

Research information that will be presented to the Departments of Anaesthesia will not have your name on it. If we publish information from this research study or use it for teaching, your name will not be used.

We will not take photographs or make audiotapes or videotapes of you without your permission.

**Can you see your research records?**

You can ask to see your research records but sometimes that can only happen after the research study is completed. If you would like to see your research records please discuss this with your study Doctor.

**STATEMENT OF VOLUNTARY CONSENT**

I have read this form or have had it read to me. I have been told what to expect if I take part in this study, including possible risks and possible benefits. I have had a chance to ask questions and have had them answered to my satisfaction. I have been told that the people
listed in this form will answer any questions that I have in the future. By signing below, I am volunteering to be in this research study.

Legal Representative's Name (Print): ________________________________

Relationship to Participant (ex. Parent, Spouse, Legal Guardian) (Print): __________

Signature: ___________________________________________ Date: ______

_________________________________________________________

_________________________________________________________

(If applicable)Participant's Name (Print): ________________________________

Signature: ___________________________________________ Date: ______

_________________________________________________________


**STUDY REPRESENTATIVE STATEMENT**

I have explained the purpose of the research, the study procedures, the possible risks and discomforts, the possible benefits, and have answered all questions to the best of my ability.

Study Representative's Name (Print): ________________________________

________________

Signature: _____________________________________________________
Date: ______________  Time Consent Obtained: __________

You will receive a copy of this form after it has been signed and dated.
Appendix 3

RUGWARO RWOKUBVUMA KUVA MUTSVAKURUDZO

ZITA RETSVAKURUDZO

Kubudisa pachena chokwadi yezvinowanikwa mukurapa varwere vanenge vanonoswa kana kunonokerwa pamwe neavo vanenge vanyimwa mukana wokupiwa mubhedha muwadhi yavanorwarisisa kana vano nyanya kuda rubatsiro nguva dzose munemichina yemhando yepamusoro yokurapa nokubatsira varwere pazvipatara zveParirenyatwa neHarare Central.

MUMWE WEVAKURU VETSVAKURUDZO : Dr. Pagwiwa

NHENGO YEVARIMUTSVAKURUDZO ............................................................... 

Kana uri mubereki kana muchengeti womwana achiri pasi pemakore gumi nemasere, kana kuti mumiririri zviri pamutemo wemunhu wabve zera, “iwe” murugwaro mvumo ishoko rinonongedza kumwana kana kuno wabve zera anenge arimutsvakurudzo.
SEI UCHIKUMBIRWA KUTI UTORE RUPANDI MUTSVAKURUDZO IYOYI

Tiri kutaura newe pamusoro petsvakurudzo iyoyi nechikonzero chokuti wawonekwa uri murwere (nhengo) anokodzera kupiwa mubhedha muwadhi yevanoda rubatsiro rwakanyanya mune michina yemhando yepamusoro. Kubvuma kutora rupandi mutsvakurudzo ino, kana kusarudza kusava mutsvakurudzo ino, hazvishanduri murapirwo kana machengereterwo akanaka amunogara muchipiwa. Sarudzo ikodzero yenyu.

Rugwaro rwuno runokupai dzidziso yakakosha, Munokumbirwa kuti munyatso verenga zvakanaka, zvakadzama mugobvunza mibvunzo musati maita sarudzo. Mungangodavo kutanga mataura pamusoro petsvakurudzo iyoyi nemhuri yenyu, kana ne shamwari, kana neavo vanosikubatsirai pane zvoutano hwenyu. Munokumbirwa kuti mutore nguva yenyu muchifunga nezvazvo musati maita sarudzo. Musanyora zita renyu parugwaro rwuno kusvikira mibvunzo yenyu yose yapindurwa zvinokugutsai.

NEMHAKA YEI TSVAKURUDZO INO IRI KUITWA

Chinangwa chetsvakurudzo ino ndechkutsvaka kuvona kukosha kwenguva pamunotanga kupiwa mubhedha muwadhi yevanonyanya kuda rubatsiro nguva zhinji kuti zvigovonekwa pakurwara kwenyu kuti nguva yamakapiwa mubhedha yabatsira zvakadini nokuda kokuti munogona kupiwa mubhedha nguva ichakanaka kana kuti munononokerwa kana kunonoswa kupiwa mubhedha muhwadi iyoyo nokuda kwezvimwe zvikonzero.
Tsvakurudzo iyoyi ichange ichiwanepi mari yokuti igobudirira

Tsvakurudzo iyoyi ichange ichiwana mari yayo kubva muhomwe ye bazi reAnaesthesia nere vanonyanya kuda rubatisro (Critical Care Medicine).

Vanhunvanga vanosvika zana na makumi matatu na vapfumbamwe kubva kuzvipatara zve Parirenyatwa neHarare Central.
UCHANGE URI MUTSVAKURUDZO IYI KWENGUVA YAKADINI

Kutora kwenyu rupandi mutsvakurudzo iyoyi zvinotarisirwa kutora nguva inobva musi wa 1 Nyamavvu 2013 kusvikira musi wa 30 Chikumi 2014. Kuva kwako mutsvakurudzo iyi kunogona kumiswa:

1. Kana chiremba anotungamirira tsvakurudzo iyoyi akavona kuti zvine zvazvakanakira kuti umiswe.

2. Vuye kana akavona kuti hausi kutevedzera zvinodikanwa mukufambiswa kwetsvakurudzo iyi.


Chiremba vanogona kukutaurira dzidziso itsva inechokuita neutano hwako, zvikakonzera kushandura mafungiro ako pakuramba uri mutsvakurudzo iyoyi. kana zvakadai zvikaitika uchakumbirwa kuti unyore zita rako parugwaro rwechibvumirano chitsva.

KUVA MUTSVAKURUDZO IYI ISARUDZO INOITWA MUNHU AKASUNUNGUKA ASINGAMANIKIDZWI

Hamumanikidzwi kuti muve mutsvakurudzo iyi. Unogona kusarudza kusapinda mazviri kana kubuda mutsvakurudzo iyoyi panguva ipi zvayo yaungada. Sarudzo iyoyi yaunenge waita haikanganisi vuKama hwako nachiremba wako kana nechipatara cheParirenyatwa kana cheHarare Central, vuye haupiwe mhosva nokuda kwaizvozvo kana kurasikirwa nepundutso kana yamuro yawaifanira kunge uchiwana kana ichinge iripo.

UNENGE UCHIITEI MUTSVAKURUDZO IYI

Mutsvakurudzo iyi tinenge tichiongorora kufambira mberi kwako. Kana ukaonekwa wakakodzera kuva mutsvakurudzo iyi, uchaiswa mune chimwe chezvikwata chakafanana neavo vanenge vakanonokerwa kupinda muwadhi yeavo vari mune michina yemhando yepamusoro vachirwarisa kana kuva muchikwata cheavo vasina kunonokerwa.

NDEZVIPI ZVIBINGAMUPIN YI KANA MATAMBUDZIKO ANGAKUWIRA MUKUVAKWAKO MUTSVAKURUDZO IYI

Hapana matambudziko kana zvipingamupinyi zvaungasangana nazvo mutsvakurudzo iyi.

ZVIPINGAMUPIN YI ZVINOSANGANIKWA NAZVO MUMIVUNZO INENGE ICHIVUNZWA NEVANHU MUTSVAKURUDZO

Mutsvakurudzo munedambudziko rokusongana nemimwe mibvunzo inechokuita nehupenyu hwemunhu mbune husingafaniri kuti mumwe munhu azive nokuda kokuti zvinenge
zvichikonzeresa. Unenge wakasununguka kusiyi mibvunzo yaunoda nokuda kwechikonzero chipi nechipi zvacho chaungaziva.

UNGABATSIRIKA NEI KANA KUBATSIRWA NEI MUKUVA KWAKO MUTSVAKURUDZO IYOYI

Hapana chamunobatsirika nacho kana kuwana mutsvakurudzo iyi asi kuti zvatinodzidza kubva mairi zvinogona kuzobatsira vamwe vanhu munguva inotevera.

PANE MARI YAUNGA TARISIRWA KUBHADHARA HERE KANA KURASIKIRWA NAYO MUKUVA
KWAKO MUTSVAKURUDZI IYI

Zvose zvine chokuita nekurapa zvakaitika panguva yetsvakurudzo zvinogona kunge zvinechokuita netsvakurudzo kana kuti zvinechokuita nekurapa kunongosiitika mazuva ose. Kubatsirwa kana kurapiwa kunenge kwaitika panguva yetsvakurudzo hakubhadharwi newe kana nelInsurance yako.

KO HUNHU HWAKO HUNGA CHENGETEDZEKA SEI

Senhengo inenge iri mutsvakurudzo iyi, tichachengetedza hunhu hwako nezvese zvaunenge wawana kubva mutsvakurudzo iyi pasine mumwe wekunze anofanira kuzviziva. Zvese zvinenge zvabuda kubva mutsvakurudzo iyi zvichachengetedzwa zvakasimba muBazi redu reUtano. Tinogona kusungirwa nemutemo kuti tishambadze dzimwe dzidziso kana mashoko atakawana mutsvakurudzo iyi (zvakafanana nezvimwe zvirwere zvino tapurirana vanhu kana vaya vanoshandisa chisimba mumwe asingadi). Izvi zvinogona kubudiswa kana kushambadza kuma bazi eHurumende chete ezve utano kana kuchegetedzeka kwakanaka kwezvinhu.

Mashoko ese ari pamagwaro anenge abva mutsvakurudzo iyi achaendeswa ku Bazi (Department) rezve Utano ne Anaesthesia. Magwaro ese iwayo anenge asina kunyorwa zita rako. Mashoko anenge abva mutsvakurudzo iyi kana akabudiswa pachena kana kushandiswa pakudzidzisa vadzidzi, zita rako harishandiswi kana kute kura nezvaro.

UNOKWANISA HERE KUTI UVONE ZVINYORWA ZVAKO ZVINECHOKUITA NEWE.

Unokwanisa kuti ukumbire kutaridzwa zvinyorwa zvetsvakurudzo zvinechokuita newe, asi pane dzimwe nguva zvingagona kuitika kana tsvakurudzo ichinge yapera. Kana uchida zvinyorwa zvetsvakurudzo zvinechokuita newe, unokumbira kuti utaure naChiremba wetsvakurudzo iyoyo.
RUGWARO RWEMVUMO PASINA KUMANIKIDZWA


NYORA ZITA RAKO........................................ NGUVA (DATE) .................

SAINA (SIGNATURE)..................................................

ZITA REMUMIRIRIRI (LEGAL REPRESENTATIVE) ..........................................

HUKANA NENHENG0 (Mubereki, Murume/Mukadzi, Mumiririri)

ZITA ..........................................................................................................................

SAINA ZITA (SIGNATURE)........................................ NGUVA (DATE)
TSANANGURO YOMUMIRIRI WEVANOTUNGAMIRIRA TSVAKURUDZO

Ndatsanangura chinangwa chetsvakurudzo, nezvinodikanwa, nemaitirwo, nezvibingamupinyi, nezvimwe zvinetswa, yamuro nepundutso vuye ndapindura mibvunzo yose nepandinokwanisa napo.

MUMIRIRIRI WEVE TSVAKURUDZO (ZITA) ..............................................................

SAINA (SIGNATURE) ..................................................................................................

MUSI (DATE)................................. NHAMBO/ NGUVA (TIME)........

Uchapihwa urwu rugwaro kana rwanyorwa Zita(signature) nemusi(date) nenguva(time)
APPENDIX 4

DATA SHEET

NAME OF PATIENT………………………………………………

HOSPITAL NUMBER………………………………………………

AGE……………………………………………………………………

SEX……………………………………………………………………

DIAGNOSIS…………………………………………………………

OPERATION DONE (if applicable)………………………………

DATE AND TIME OF REFERRAL TO ICU…………………………………………………………

DATE AND TIME OF ADMISSION TO ICU…………………………………………………………

TIME TAKEN FROM REFERRAL TO ADMISSION…………………………………………

REASON FOR ADMISSION TO ICU……………………………………………………………

IS THERE A DELAY OF MORE THAN 4 HOURS FROM REFERRAL TO ADMISSION(Y/N)?

IF ANSWER IS YES, WHAT IS THE REASON: ………………………………………

DAYS ON MECHANICAL VENTILATOR…………………………………………………………

TRACHESTOMY(Y/N)…………………………………………………………………………


INOTROPIC SUPPORT REQUIRED (Y/N) .................................................................

DURATION ON INOTROPIC SUPPORT .............................................................

RENAL REPLACEMENT THERAPY REQUIRED (Y/N) ........................................

DURATION ON RENAL REPLACEMENT THERAPY ...........................................

DATE OF DISCHARGE FROM ICU .................................................................

DID PATIENT DECEASE ..............................................................................

DURATION OF ICU STAY ...........................................................................

THE EARLY WARNING SCORE

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</table>

V-response to verbal

P-response to pain
U-unconscious

A-awake
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14. Carol Ball, Kirkby M, Williams S. Effect of the Critical Care outreach team on patient survival to discharge from hospital and readmission to critical care, non randomised population based study. *BMJ. 2003 Nov 1; 327(7422):1014.*


