ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF MEDICINE

DEPARTMENT OF EMERGENCY MEDICINE

Disaster surge capacity rise through reverse triage in Addis Ababa hospitals; cross-sectional study

Principal investigator: Dr. Tsion Seyoum (MD)

Advisors: Professor Aklilu Azazh (Internist and professor of ECCM)

Dr.Lemlem Beza (Assistant professor, Post doc fellow)

Dr. Bitanya Debalkew (Assistant professor of ECCM)

A thesis submitted to Addis Ababa University, College of Health Sciences, School of Medicine, Department of Emergency Medicine in Partial Fulfillment of the Requirements for Postgraduate Specialty Certificate in Emergency and Critical Care Medicine

January, 2024

Addis Ababa, Ethiopia

ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF MEDICINE

DEPARTMENT OF EMERGENCY MEDICINE

Disaster surge capacity rise through reverse triage in Addis Ababa hospitals; cross-sectional study

Principal investigator: Dr. Tsion Seyoum (MD)

Advisors:

Professor Aklilu Azazh (Internist and professor of emergency and critical care medicine)

Dr.Lemlem Beza (Assistant professor, Post doc fellow)

Dr. Bitanya Debalkew (Assistant professor of emergency and critical care medicine)

January, 2024

Addis Ababa, Ethiopia

Declaration

I**,** Tsion, declare that this is my original work and that all sources of materials used for this thesis are properly acknowledged.

Name: Tsion Seyoum, MD

Email: tsionseyoun1616@gmail.com

Signature ……..

Date of Submission: …….

Place: Addis Ababa, Ethiopia

This thesis has been submitted for examination with my approval as university advisor.

Name of Advisor: 1. Professor Aklilu Azazh (Internist and professor of emergency and critical care medicine)

Signature: …….

Date: …….

2. Dr.Lemlem Beza (Assistant professor, Post doc fellow)

Signature: ……

Date: ……

3. Dr. Bitania Debalkew (Assistant professor of emergency and critical care medicine)

Signature: ……

Date: ……

Name of Examiner: ……

Signature: ……

Date: ……

Acknowledgements

I owe a debt of gratitude to my advisors for helping me develop this thesis and for their insightful feedback.

The hospital staffs of Zewuditu Memorial Hospital (ZMH), Addis Ababa University (AAU), and St. Paul's Millennial Medical College (SPHMMC) are also appreciated for their contributions to this study.

Furthermore, I would like to express my gratitude to the department of emergency and critical care medicine for providing me with the means to carry out this research.

Contents

Declaration..... 1

Acknowledgements 2

List of tables..... 6

List of figures..... 6

Abbreviations 7

Abstract..... 9

1. Introduction..... 10

1.1 Background 10

1.2 Statement of the problem 10

1.3 Significance of the study 11

2. Literature review 12

3. Objectives of the study..... 17

3.1 General Objective:..... 17

3.2 Specific Objectives:..... 17

4. Methods and materials 18

4.1 Study setting/area 18

4.2 Study design and period 19

4.3 Population..... 19

4.3.1 Source population 19

4.3.2 Study population 19

4.4 Eligibility criteria 19

4.4.1 Inclusion criteria 19

4.4.2Exclusion criteria 19

4.5 Sampling size determination and sampling technique 19

4.5.1 Sample size 19
4.5.2 Sampling technique 20
4.6 Data collection tool, methods and procedures 20
4.6.1 Data Collection Tool: 20
4.6.2 Methods and procedures: 21
4.7 Study variables 21
4.7.1 Dependent variable: 21
4.7.2 Independent variables: 21
4.8 Operational definitions 21
4.9 Data quality control 22
4.10 Data processing and analysis 22
4.11 Ethical considerations 23
4.12Plan for dissemination of results 23
5. Results 24
5.1 Socio demographic characteristics of respondents 24
5.2 Reverse triage score 25
6. Discussion 27
7. Strengths and Limitations 29
7.1 Strengths 29
7.2 Limitations 30
8. Conclusion and Recommendations 30
8.1 Conclusion 30
8.2 Recommendations 31
9. References 31
Annexes 34

Annex 1: Consent form 34

Annex 2: data collection tools 35

List of tables

Table3. 1 Demographic Characteristics 24

Table4. 1 Reverse triage Tool Leuven score of Addis Ababa Hospitals 26

Table5. 1 Binomial logistic Regression analysis 27

Table6. 1Reverse Triage Tool Leuven (RTTL) checklist..... 35

Table7. 1 KATZ INDEX OF INDEPENDENCE IN ACTIVITIES OF DAILY LIVING 37

Table8. 1Description of Study Population by Institution 39

Table9. 1 Clinical intervention tool of reverse triage 38

List of figures

Figure1. 1 Admissions, discharges and occupied beds in Royal Darwin Hospital for April 2009. 14

Figure2. 1 Reverse Triage Tool Leuven Score of Addis Ababa Hospitals, Positives (non dischargeable), Negatives (dischargeable)..... 25

Figure2. 2 Gross surge capacity of three hospitals before (1) and after (2) Reverse triage..... 26

Abbreviations

AAU: Addis Ababa University

ADL: Activity of daily life

BLH: Black Lion Hospital

B: Unstandardized regression coefficient

CI: Critical intervention

CME: Consequential medical events

df: degree of freedom

ED: Emergency Department

EMCC: Emergency medicine and critical care

Exp(B): odds ratio

ICU: Intensive care unit

i.e.: That is

IT: Information technology

MCIs: Mass casualty incidents

PGY: Post graduate year

RDH: Royal Darwin Hospital

RT: Reverse triage

RTTL: The Reverse Triage Tool Leuven

S.E: Standard of error

Sig: Significance value

SPHMMC: St. Paul's Hospital Millennial Medical College

SOFA: Sequential organ failure assessment

TASH: Tikur Anbessa Specialized Hospital

X^2: Chi-square

ZMH: Zewuditu Memorial Hospital

Abstract

Background: Plans must be in place before a disaster or pandemic strikes in order to reduce damage and maintain control. Hospitals play a leading role in disaster and incidence response by identifying inpatients that can be safely discharged early, and can create additional surge capacity. Implementing reverse triage allows hospitals to optimize resources and prioritize patients based on their medical needs.

Objective: Computing the impact of reverse triage on an increase in surge capacity of hospitals in Addis Ababa, Ethiopia during disaster.

Methods: Hospital based -cross sectional study was carried out to gather primary data from three public hospitals (TASH, SPHMMC and ZMH) which were included by convenience sampling and data was collected from September 1 to 30, 2023. Descriptive statistics, binomial logistic regressions was employed to identify factors associated rise in hospital surge capacity.

Results: A total of 296 participants met the eligibility criteria were included in the study. Most of the individuals involved 136(45.9%) fell within the age group of 13-34 years. More than half study participants, 164 (55 %) were female. In the vast majority of cases 205(69.3%), the source of admission was the Emergency Department. Patients were assessed for early discharge based on their reverse triage score using Reverse Triage Tool Leuven (RTTL). The approximate percentages of patients who qualify for an early discharge were 58.4% (95% CI 52.6% - 64.1%). The approximate percentages of patients who qualify for an early discharge in each hospital were 66.7% (95% CI 54% -77.8%) at Zewuditu Memorial Hospital (ZMH), 57.6 %(95% CI 49.5% - 65.4%) at Blacklion Hospital (BLH), and 52.8% (95% CI 40.7% -64.7%) at St. Paul Millennial Medical College (SPMMC).

Conclusion: This study has showed Reverse triage's impact on increasing surge capacity in Addis Ababa's healthcare facilities during catastrophic event in a short period of time.

Keywords: Reverse Triage tool Leuven, Disaster, Surge capacity, Inpatient units.

1. Introduction

1.1 Background

Systems in the healthcare industry are supply-constrained, with demand that varies and is unexpected. The healthcare system has to decide how to distribute its resources when the amount of demand exceeds the amount of supply. The overwhelming need at times of extraordinary demand, like mass casualty incidents or natural disasters, can cause the healthcare system to become nearly non-functional. [1].

A technique called reverse triage was created to deal with the limitations of inpatient capacity in the event of a disaster. By identifying hospitalized patients who do not require considerable medical support and who only have a modest risk of serious repercussions from an early discharge; it is possible to quickly establish inpatient surge capacity. [11].The largest number of resources that could possibly be accessible at any one time is known as the surge capacity. [16].

Emergency departments (EDs) are often overcrowded, leading to long wait times and delays in care, strained ED resources. Several operational inefficiencies contribute to ED overcrowding, chief among them being the limited availability of inpatient beds. As a result, patients are admitted to the ED and boarded. [11]. Reverse triage, which prioritizes ED patients with urgent needs over inpatients that may be discharged with little to no health concerns, may be a reaction to this type of ED overpopulation. [12].

1.2 Statement of the problem

The results of one systematic review back in 2016 G.C found very few papers discussing reverse triage, suggesting that research on reverse triage and surge capacity is still in its infancy in the medical field. [11].Despite its potential benefits, there is no research done about reverse triage in creating surge capacity in Africa. Now days disaster is becoming a common issue which put health care centers in a great constrains which needs a solution. Experts and decision-makers can use the study as a helpful reference to create effective incident management. The work may serve as a foundation for more research.

1.3 Significance of the study

Primarily, the study sought to evaluate hospitals bed capacity before and after implementation of reverse triage tools in inpatient unit patients in three hospitals in Addis Ababa (A.A) and helping to determine disaster surge capacity rise through reverse triage in A.A hospitals. Understanding the reverse triage capacity can help emergency management authorities in Addis Ababa to better prepare for potential surges in healthcare demand .By identifying and assessing the resources available for reverse triage, they can develop strategies and plans to effectively handle large influxes of patients during emergencies or disasters.

Reverse triage aims to prioritize patients based on their clinical condition and likelihood of survival. By studying its capacity, healthcare professionals can ensure that patients receive appropriate care based on their needs and available resources. This can help maximize the chances of survival for critically ill patients during times when healthcare systems are overwhelmed.

The findings from this study have the potential to have widespread applicability beyond Addis Ababa, offering valuable insights and experience for other regions encountering comparable difficulties in effectively handling surge capacity during emergencies or disasters. The outcomes of this research will contribute to the development of best practices and guidelines that can be readily adopted by other urban centers or rural straggled with similar resource constraints.

2. Literature review

Mass casualty incidents (MCIs), COVID-19 pandemics, Furthermore, daily crowding in the Emergency Department (ED) causes unanticipated, abrupt rises in the number of patients. An ED and, by extension, the hospital's capacity and resources may be readily overwhelmed by this significant influx brought on by MCIs or ED crowding. New technology and triage systems have been researched in the hunt for coping mechanisms. [2-6] ED crowding will happen if full surge capacity is not reached in a timely manner, which could result in an increase in morbidity and mortality as well as a general decline in the quality of patient treatment. [7-10].

By giving priority to hospitalized patients who require the least amount of medical attention and only have a slight chance of serious repercussions from an early discharge, reverse triage is a technique for quickly creating inpatient surge capacity. In mass casualty incidents (MCIs), these patients can be promptly discharged to make way for the disaster victims, who require more hospital resources and care.[14] Low-risk patients may be sent home or to less intensive care settings including assisted living centers, public health emergency rooms, or on-site nursing homes.[10–11] It is well known that reverse triage, which makes new beds accessible in two to four hours, increases the facility's surge capacity. [15]

An early-discharge strategy was used in a study by Kelen et al. to assess the possible surge capacity of three hospitals in the United States. Over the course of 19 weeks, Kelen et al. conducted a prospective study of the elective wards at three different hospitals: an academic hospital, an affiliate hospital, and a community hospital. The severe and life-threatening disease score in this study was 10, by employing a clinical intervention scoring tool for reverse triage, the severity of the sickness was reduced to 3. According to the data, 40% of patients at academic hospitals, 47% in teaching hospitals, and 59% in non-educational community hospitals were eligible for early discharge. It should be emphasized that early discharge was more common in the Kelen et al. trial; individuals who were deemed ready for discharge after four days and who did not require emergency care or supervision were eligible for discharge. According to their study's findings, each hospital's additional capacity was primarily created through reverse triage. [10]

In order to better understand how RT might be used to increase hospital surge capacity in one of Isfahan, Iran's primary academic referral hospitals, a cross-sectional study was carried out in 2015 at Al-Zahra Subspecialty Hospital. At Isfahan Al-Zahra Hospital, running RT in 41 wards and units increased hospital capacity by 20% on average. [19] In order to use the reverse triage approach, the top ten illnesses that resulted in hospitalization in each hospital ward in 2014 were first examined, sorted, and listed according to their prevalence. The expert panel then wrote and accepted academic guidelines for making a decision and the prospect of early discharge based on Handbooks of Emergency Medicine [21], taking into consideration that no substantial risk will threaten the patients in the following 96 hours. [19]

56 beds (16% of the hospital's 350 beds) were created as part of a plan to build surge capacity at the Royal Darwin Hospital (RDH) so that explosion injury cases from a boat carrying asylum seekers may be admitted in 2009. In order to accommodate blast victims on the day of the disaster, when RDH was asked to take up to 30 casualties suffering from blast injuries, surge capacity was made available in Royal Darwin Hospital through a combination of canceling all planned admissions, discharging some patients at least one day earlier than planned, and discharging all patients earlier in the day. There was a backlog of patients in the emergency room waiting to be admitted, and the hospital was full. Reverse triage is noteworthy since it did not raise clinical risk; in fact, just one patient who was discharged early returned for additional care. Figure 1.1 illustrates that a rise in discharges, as opposed to a fall in admissions, was the primary cause of the decreased occupancy on the day of the disaster. As a result, there was a bigger discrepancy between discharges and admissions, which led to more beds becoming available. [22]

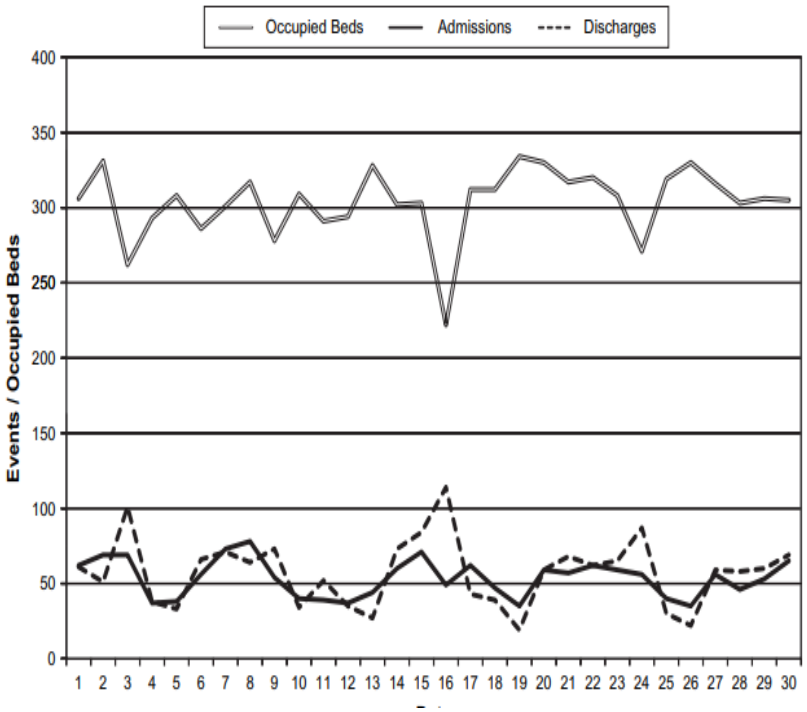

Figure1. 1 April 2009 admissions, discharges, and occupied beds at Royal Darwin Hospital.

A monocentric study conducted at the University Hospitals of Leuven tested a clinical decision support tool based on the reverse triage principle to help patients exit the hospital more easily. In the event of mass casualty disasters, this program, the Reverse Triage Tool Leuven (table 6.1), was able to identify hospitalized patients who unquestionably could not be discharged early. [12]

A clinical decision support tool for the reverse triage selection process was created and assessed in studies using an evidence-based IT application. The program was developed for mass casualty incidents (MCIs), which are catastrophic scenarios that result in the requirement for hospitals to have extra capacity. Using objective medical criteria, the Reverse Triage Tool Leuven (RTTL) evaluates all hospitalized patients and eliminates those who are not eligible for early discharge in the event of a disaster, leaving a list of only those who may be discharged. Before these patients are truly sent home or have their level of care reduced, a multidisciplinary team consisting of a physician, nurse, and social assistant must do a clinical reevaluation. [14] After verification, the RTTL might develop into a useful clinical decision support tool for reverse triage. Moreover, following a great deal of fine-tuning, its possible application in everyday surge scenarios in hospitals ought to be looked into, since emergency rooms encounter crowding almost every day.[15]

In the event of ED crowding, this would not be acceptable, in contrast to MCIs when a certain level of risk will be accepted. Consequently, when it comes to ED crowding, the cut-off values of reverse triage in the case of MCI to identify in patients who are not ready for hospital discharge may need to be revisited. An e-Delphi study with a European expert panel is presently underway to update and reevaluate the underlying American framework, as well as to revise the definitions and cut-off values for daily ED congestion. [13]

In order to assess the application of reverse triage in medical inpatients at an Italian hospital, Valeria Carallo et al. conducted an observational prospective study in which they compared the RT score to the National Early Warning Score, Sequential Organ Failure Assessment, and Charlson Co morbidity Index. RT, NEWS, SOFA, and CCI are computed using inpatient charts. Length of stay (LOS), transfer to a higher level of care, and date of release were all gathered for this study. They acquired information on the inpatients' demographics, co-morbidities, severity, and clinical complexity. They emphasized the variations across the three divisions' NEWS, SOFA, and CCI. On the other hand, 85% of patients had an RT=8, and the RT score was consistently high (median 7). Patients with greater RT scores also had higher NEWS, SOFA, and CCI scores. As a stand-in for the required degree of care, they employed the total of the interventions indicated by RT (RT sum). A moderate association was observed between RT-sum and NEWS ($r=0.52$ Spearman, $p<0.001$). Regardless of variations in NEWS, SOFA, and CCI in several ward subgroups (high dependency unit (HDU), geriatrics (Ger), and internal medicine (IM) wards), the RT score had comparable values in the majority of the inpatients. Clinical complexity (CCI) and increasing severity (NEWS) are both correlated with RT-sum. The inpatient level of care and resource requirements related to CCI might be predicted by RT and NEWS. According to NEWS's widespread application, RT-sum and NEWS are most likely the most concordant and helpful instruments for directing inpatient disposition, especially when deciding whether to transfer to a higher level of care. However, if the discharge procedure is the main emphasis, the RT score can be used to predict which patients will be released in the next days, but it's also important to consider the complexity assessment. In contrast, SOFA is a more reliable indicator of mortality in their research. They proposed integrating the RT score, RT total, and NEWS score into a decision-making system to assign the appropriate degree of care and allocate resources optimally [18]. When applied for the first time in a non-disaster situation, reverse triage (RT) with a cut-off < 3 has shown to be a cautious and safe technique with a low incidence of unfavorable occurrences.

Just a tiny portion of inpatients are identified by RT as being eligible for discharge, although RT has a high specificity for early discharge (≤4 days after assessment). [20]

3. Objectives of the study

3.1 General Objective:

Quantifying the impact of reverse triage for surge capacity of hospitals in Addis Ababa, Ethiopia during disaster.

3.2 Specific Objectives:

1. To characterize traits of selected eligible patients based on basic demographic information, inpatient unit type, and source of admission

2. To determine factors affecting reverse triage for early discharging patients.

3. To determine the current surge capacity of hospitals in Addis Ababa for managing disasters.

4. Methods and materials

4.1 Study setting/area

The study was conducted in three public hospitals in Addis Ababa, namely AAU/BLH (TASH), SPHMMC, and ZMH. These hospitals were selected based on convenience, with one hospital chosen from an academic institution, one from the Ministry of Health, and one from Addis Ababa city hospitals. Black Lion Hospital (BLH) is Ethiopia's largest general public hospital and one of the University Hospitals in the country. It was founded in 1950, and on March 26, 1963, the faculty of Medicine received official approval. In 1998 Black Lion Hospital, was given to Addis Ababa University (AAU) by the Ministry of Health (MOH) for the faculty as a main teaching hospital.AAU has regained its autonomous status after nearly 50 years in August,2023.The faculty is the oldest and the largest among the health training institutions in the country, staffed with the most senior specialists. The hospital provides a tertiary level referral treatment and is open 24 hours for emergency services. The hospital is administered by Addis Ababa University and is the largest and oldest teaching hospital among all in Ethiopia providing teaching for about 300 medical students and 350 Residents every year. Black Lion hospital offers diagnosis and treatment for approximately 370,000- 400,000 patients a year. The hospital has 519 inpatient beds, with 130 specialists, 50 non-teaching doctors. The emergency department sees around 80,000 patients a year.

St Paul's Millennium Medical College (SPHMMC), as it is known today, was established through a decree of the Council of Ministers in 2010, although the medical school opened in 2007 and the hospital was established in 1968 by the late Emperor Haile Selassie. It is governed by a board under the Federal Ministry of Health. The college has more than 2800 clinical, academic and administrative and support staffs that provide medical specialty services to patients who are referred from all over the country, teaching medicine and nursing students and doing basic and applied researches. While the capacity is about 618 beds, The College sees an average of 1200 emergency and outpatient clients daily.

Zewditu Memorial Hospital (ZMH) is a university affiliated general hospital in central Addis Ababa, Ethiopia. It is one of the oldest public hospitals in Addis Ababa. It was established back in 1910 ,built, owned and operated by the Seventh-day Adventist Church, but was nationalized during the Derg regime in about 1976. The hospital is named after Empress Zewditu, the cousin

and predecessor on the throne of Emperor Haile Selassie. Today, ZMH is operated by the Ministry of Health. The hospital has about 227 inpatient beds.

4.2 Study design and period

Institutional based prospective cross-sectional study design, which involves collecting data at a specific point in time from selected inpatient units of the hospitals. The data was collected from September 1 to September 30, 2023 through pre tested checklist.

4.3 Population

4.3.1 Source population

All Patients who were admitted to TASH, SPMMC and ZMH.

4.3.2 Study population

Patients who were admitted to the selected inpatient units at TASH, SPHMMC and ZMH who fulfill the inclusion criteria.

4.4 Eligibility criteria

4.4.1 Inclusion criteria

1. Patients who were 13years old and above and admitted to inpatient units

2. Patients with non-critical medical conditions i.e. those who did not need Intensive care unit (ICU) admission

3. Patients who were stable and not in need of immediate medical attention

4.4.2Exclusion criteria

1. Patients with critical medical conditions requiring immediate medical attention

2. Patients who are admitted to pediatrics units, newborn units, and ICUs, labor ward

3. Patients who refused to participate in the study

4.5 Sampling size determination and sampling technique

4.5.1 Sample size

The required sample size was calculated using single population proportion sampling method.

$$\mathbf{n = z_{\alpha/2}^2 * P(1-P)/d^2}$$

Here, Za/2 is the value under the normal standard table for the provided confidence interval (1.96 for the 95% CI), and n is the required minimum sample size. P is the best estimate of prevalence because no previous research has been done in our nation; we increased the sample size by 50%; d is the margin of error (0.05); and n = $(1.96)^2$*0.5(1-0.5)/ $(0.05)^2$ = **384**

As the population under consideration was less than 10,000, the above formula modify by the following sample correction method;

Corrected sample size = **n*N/ n+N**.

Where n is the sample size we calculate (384), N is our total population (892)

The corrected sample size had become 268.

To avoid selection bias we revised the calculated corrected sample size using non response rate.

= 268 +10% (non-response rate) = 298

Estimated eligible number of patients from TASH =479, ZMH =200 SPMMC=213 .Total=892

From TASH **158** patients were selected from 479 eligible patients (298/892*479**)**, from ZMH **66** patients were selected from 200 eligible patients (298/892*200), from SPMMC **70** patients were selected from 213 eligible patients (298/892*213).

Two samples were excluded due to inconvenience from the 298,296 samples that were obtained out of the target.

4.5.2 Sampling technique

Simple random sampling method was used to select patients among eligible population in each study units. After determining the sample size we needed from each unit we randomly selected bed numbers till the determined sample size achieved.

4.6 Data collection tool, methods and procedures

4.6.1 Data Collection Tool:

The data collection was from patient charts and documents through survey using a checklist designed to collect information about patients to use for reverse triage tool and their basic socio demographic status and characters. In addition, licensed staffed, unstaffed bed numbers of selected

inpatient units, and bed occupancy rate were collected from Health Management Information systems (HMIS) files.

4.6.2 Methods and procedures:

1. Total number of licensed staffed, unstaffed bed numbers of selected inpatient units, and bed occupancy rate was collected from Health Management Information systems (HMIS) through prepared checklist

2. Reverse Triage Tool Leuven (RTTL) score was be calculated for each selected patient and was recorded on the checklist

3. Study population characters (age, sex, admission source, inpatient unit) were collected from patients chart and plotted on a table

4.7 Study variables

4.7.1 Dependent variable:

Estimated number of patients who could be discharged safely after Reverse Triage.

4.7.2 Independent variables:

1. socio-demographic characters of patients
2. Source of admission
3. Type of inpatient units
4. Type of hospital

4.8 Operational definitions

Consequential medical event (CME): is defined as an unexpected death, irreversible impairment, or reduction in function within 72 hours of hospital discharge for which an in-ho7pital critical intervention (CI) would have been necessary to stabilize or ameliorate the patient's condition [13].

Critical intervention (CI): Critical interventions are procedures which exist on a spectrum of necessity and ability to address a consequential event, ranging from cardiopulmonary resuscitation (CPR) to basic assistance with activities of daily living [13].

Licensed beds: are those beds for which a facility has been granted approval to operate from the applicable state licensing agency.

Mass causality incident (MCI): is defined as an event that overwhelms the local healthcare system, where the number of casualties vastly exceeds the local resources and capabilities in a short period of time [24].

Reverse Triage: is a way to rapidly create inpatient surge capacity by prioritizing hospitalized patients who need the least amount of medical assistance and only have a small risk for serious complications resulting from early discharge [14].

Reverse Triage Tool Leuven (RTTL): the RTTL assesses hospitalized patients using objective medical criteria as listed in RTTL table, and filters out those who do not qualify for early discharge if they score at least one criteria from the listed ones. [16]

Safe early discharge: Either Reverse triage (RT) with CI score cut-off ≤ 3 or with no any RTTL criteria is proved to be a safe and conservative tool with low rate of adverse events. [10, 12]

Staffed beds: include those that are licensed and physically available with staff on hand to attend to patients.

Surge capacity: defined as the maximum potential augmentation of resources available to care for the influx of an unexpectedly large number of patients [13].

Unstaffed beds: Beds that are licensed and physically available and have no current staff on hand to attend to a patient who would occupy the bed.

4.9 Data quality control

Data collection was done using a tool adopted from previous similar study after the necessary modification. [15]The data collection tool was prepared in English and pre-tested 10 % of the sample size (30 units). In addition based on the feedback from the pre-test study the format and wording of the questions were corrected and revised.

4.10 Data processing and analysis

Data were evaluated for completeness, cleaned, coded, and entered into SPSS version 27 for analysis. Descriptive analysis was performed to summarize the findings while tables and diagrams

were used to present the information. Binomial logistic regression was conducted to test associations between dependent and independent variables. A statistically significant association was declared at a cut-off p-value of $p<0.05$.

Gross Capacity of the 3 Study Hospitals during the study period was described by a proportion derived from Bed occupancy rate of the hospitals during the study period.

4.11 Ethical considerations

Ethical approval was obtained from each hospital research committee and an official cooperation letter was written from department of emergency medicine. So, permission from each study setting was granted to access the required data. Furthermore, informed consent was secured from each study participants. The confidentiality of the information collected from respondent was maintained. In addition all the procedure involved in this study has adhered to ethical principle.

4.12Plan for dissemination of results

The findings of this study will be submitted to Emergency and critical care Medicine Department of Addis Ababa University (AAU), as a partial fulfillment of Specialty Certificate in Emergency and Critical care. As the results are expected to contribute significantly for the health system management effort will be exerted to notify the Federal Ministry of Health (FMOH) on the overall picture of the findings for future planning and implementation. Finally, the manuscript will be submitted to a reputable scientific journal for possible publication.

5. Results

5.1 Socio demographic characteristics of respondents

A total of 296 participants met the eligibility criteria were included in the study. The majority of the participants 136(45.9%) fell within the age group of 13-34. More than half study participants, 164 (55 %) were female. In the vast majority of cases 205, (69.3%), the source of admission was the Emergency Department. Additionally, a large proportion of the study participants 86, (29.1%) were admitted to the surgical ward, while 82 (27.7%) were admitted to the medical ward. (Table 3.1)

Table3.1 Socio demographic Characteristics

		Count	Percentage/ %
Age of patients	13-34	136	45.9%
	35-44	67	22.6%
	45-54	38	12.8%
	55-64	30	10.1%
	65-74	14	4.7%
	>74	11	3.7%
Sex of patients	Female	164	55.4%
	Male	132	44.6%
Admission source	Emergency Department	205	69.3%
	Elective/Direct admission	91	30.7%
Inpatient unit type	Surgical ward	86	29.1%
	Medical ward	82	27.7%
	Obstetrics/Gynecology ward	67	22.6%
	Oncology ward	38	12.8%
	Orthopedics ward	16	5.4%
	Psychiatry Ward	7	2.4%

5.2 Reverse triage score

Patients were assessed for possibility early discharge based on their reverse triage score using RTTL negative. Using one sample non parametric test the estimated proportion of patients eligible for early discharge, including those already designated for discharge, were 58.4% (95% CI 52.6% - 64.1%). The estimated proportion of patients eligible for early discharge in each hospital were 66.7% (95% CI 54% -77.8%) at Zewuditu Memorial Hospital (ZMH), 57.6 %(95% CI 49.5% - 65.4%) at Blacklion Hospital (BLH), and 52.8% (95% CI 40.7% -64.7%) at St. Paul Millennial Medical College (SPMMC). (Table4.1)

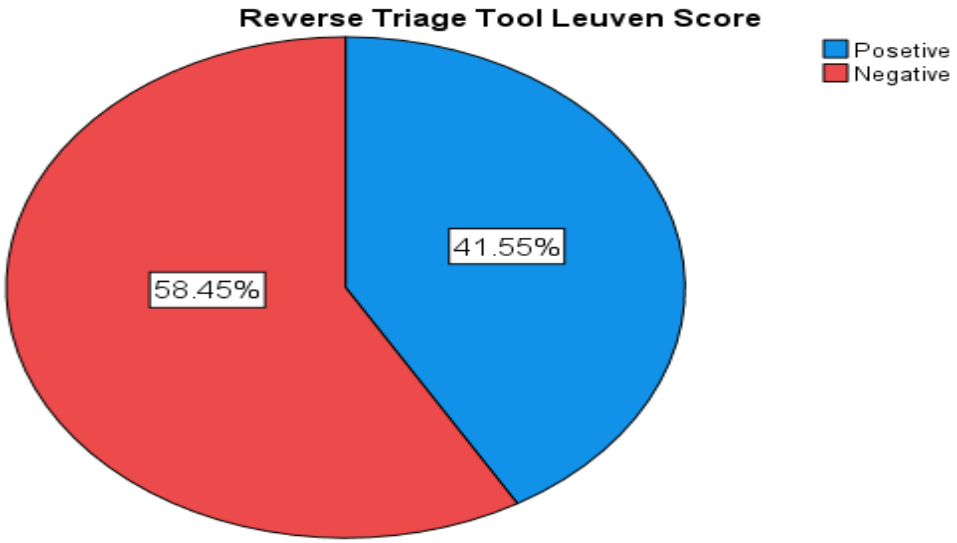

Figure2. 1 Reverse Triage Tool Leuven Score of Addis Ababa Hospitals, Positives (non dischargeable), Negatives (dischargeable)

Table4. 1 Reverse triage Tool Leuven score of Addis Ababa Hospitals

		Hospital Name					
		Zewuditu Memorial Hospital		Blacklion Hospital		St.Paul Millennial Medical College	
		Total Number	Percentage ,95%CI	Total Number	Percentage,95%CI	Total Number	Percentage,95 %CI
RTTL	Positive	22	33.3%(22.2-46)	67	42.4%(34.6-50.5)	34	47.2%(35.3-59.3)
	Negative	44	66.7%(54-77.8)	91	57.6%(49.5-65.4)	38	52.8%(40.7-64.7)

Given the mean floor census 82.3%, 71.6%, 76% of ZMH, BLH and SPMMC respectively which is the bed occupancy rate (BOR) of each hospital during the study period, they had an average 17.7%, 28.4%, 24% readily available capacity from staffed unoccupied beds. Summing up the freed up spaces using reverse triage together with staffed unoccupied beds will give the gross surge capacity 84.4%, 86% and 76.8% in ZMH, BLH, and SPMMC respectively (figure2.2)

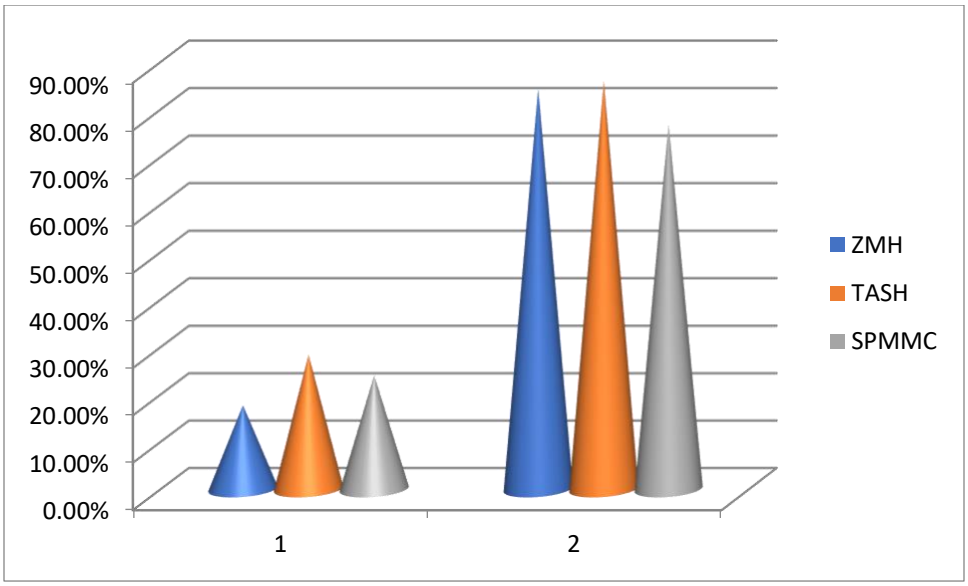

Figure2. 2 Gross surge capacity of three hospitals before (1) and after (2) Reverse triage

Logistic regression was performed to ascertain the effects of age, sex, inpatient unit type, source of admission and hospital type on the probability of early discharge using reverse triage. A total of 296 patients were used in the analysis. The logistic regression model was statistically significant(X^2=45.520;df=3;P<0.001).The model explained 19.2% of the variation in early discharge using reverse triage and correctly classified 69.6% of cases. (Table 5.1)

Table5. 1 Binomial logistic Regression analysis

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Age of patients	.230	.104	4.881	1	.027	1.259
Sex of patients	.243	.286	.721	1	.396	1.275
Admission source	.081	.352	.053	1	.818	1.085
Inpatient unit type			21.418	5	.001	
Medical	2.196	1.164	3.560	1	.059	8.991
Surgical	2.576	1.136	5.146	1	.023	13.151
Orthopedics	3.601	1.364	6.972	1	.008	36.619
Oncology	1.356	1.184	1.313	1	.252	3.882
Obstetrics/Gynecology	1.327	1.182	1.261	1	.262	3.768
Hospital Name			2.039	2	.361	
ZMH	-.404	.344	1.379	1	.240	.668
TASH	-.529	.388	1.854	1	.173	.589
SPMMC	-1.948	1.178	2.734	1	.098	.143

6. Discussion

The reverse triage tool we used is called the Leuven Score which was used to determine the seriousness of illness in admitted patients to wards. Accuracy and reliability of the Leuven Score in predicting patient outcomes or guiding treatment decisions were previously studied proven to

be safe.[16] According to our data, out of a total of 296 patients, 123 (41.6%) were classified as non dischargeable based on the Leuven Score, while 58.4% (95% CI 52.6% - 64.1%) were classified as dischargeable. Majority of patients (58.4%) had a negative Leuven Score, indicating a lower severity of illness which makes them a candidate for early discharge that is we could free 58.4% of occupied beds in a short period of time just by using reverse triage. The capacity of the hospitals at the beginning of our study was estimated to be 23.4% compared to 81.8% after the application of reverse triage. When we assessed each hospitals readily available capacity at the beginning of our study 17.7%, 28.4%, and 24% unoccupied beds were estimated based on each hospitals bed occupancy rate at ZMH, TASH and SPMMC respectively. After applying reverse triage scoring system the estimated gross surge capacity has increased to 84.4%, 86% and 76.8% in each respective hospital. This result suggests that a significant portion of patients might be eligible for early discharge using reverse triage, which could potentially free up hospital resources and beds for more critical patients. The results support the claim of different studies like Kelen et at (2009) which using a clinical intervention scoring tool for reverse triage, they assessed the potential surge capacities of three hospitals (an academic, an affiliate, and a community hospital) over a period of time, finding that 40%, 47%, and 59% of patients could be discharged early. They came to the conclusion that reverse triage significantly increased each hospital's capacity. Reverse triage supplied 16% of the hospital's excess capacity in 2010 at Royal Darwin Hospital. Furthermore, a cross-sectional study conducted in 2015 at the Al-Zahra Subspecialty Hospital in Iran looked into the possibility of using reverse triage to increase hospital surge capacity. The results showed 20% more spaces.

The logistic regression has showed age and inpatient unit type significantly affected the probability of early discharging patients using reverse triage. The chance that patients who were admited to Orthopedics and Surgical wards being dischargable after reverse triage were 36.6x and 13.1x higher than those in other units respectively.

The probablity of a patient in orthopedics ward being dischargable after reverse triage were 97% and those at surgecal ward were 92%.The odds of being dischargable after reverse triage increased by a factor 1.2599 for each unit increase in age,that is the chance of being dischargable is is higher in older patients compared to lower age groups.

7. Strengths and Limitations

7.1 Strengths

1. We believe a fundamental problem facing health care systems worldwide has been examined in this study. When catastrophic occurrences occur, the majority of hospitals lack the resources necessary to manage high influxes.[1] In light of resource constraints and rising healthcare costs, this study tackles the idea of the vital necessity for efficient emergency response and management.

2. As far as we are aware, this study is the first to show that reverse triage is a useful tool for expanding hospital capacity in Africa.

3. This study may help government representatives and other health experts see the need for additional implementation and revision. Additional examination and discourse may aid in assessing its efficacy in overseeing patient care and enhancing outcomes.

4. This study questions whether inpatient surge capacity is sufficient, at least in the case of short-lived catastrophic occurrences.

7.2 Limitations

1. We didn't consider ICU, pediatrics units and labor wards as those are venerable group of population who needs a special ethical consideration. Reverse triage has a significant but limited impact on hospital capacity, according to a 2017 study by Johns Hopkins Hospital on its impact on the development of surge capacity in a pediatric hospital.

2. As a result of inadequate data on length of stay, admission rate and discharge rate from each hospital our study could not show the net surge capacity of the hospitals and their contribution to the reverse triage and surge capacity of hospitals.

3. Despite the fact that other reverse triage tools, including RTTL, have been accredited in earlier studies, the RTTL tool hasn't been updated and validated by clinical judgment of doctors or healthcare professionals in our nation.

8. Conclusion and Recommendations

8.1 Conclusion

The results of the study demonstrated that implementing reverse triage in the three hospitals in Addis Ababa (ZHM, TASH and SPMMC) added 66.7%, 57.6% and 52.8% free beds raising the hospitals' surge capacity. In a general estimate 58.4% free beds can be achieved after reverse triage, raising the surge capacity of hospitals in Addis Ababa. Our findings call for large scale study by combining other strategies.

8.2 Recommendations

The study proved that reverse triage is a useful strategy for boosting surge capacity. As a result, we advise the administration of Addis Ababa Hospital and other medical institutions to start thinking about introducing reverse triage procedures during periods of increased patient traffic or medical emergencies.

We recommend medical professionals and physicians in our nation to assess reverse triage instruments within the national context.

Further research can be conducted to explore the long-term effects of implementing reverse triage in hospitals beyond surge capacity management. This may include evaluating patient outcomes.

9. References

1. Justice J, Walker III JR. EMS Reverse Triage.

2. Femy F, Follin A, Juvin P, Feral-Pierssens AL. Terrorist attacks in Paris: managing mass casualties in a remote trauma center. European journal of emergency medicine. 2019 Aug 1;26(4):289-94.

3. Freund Y. The European Journal of Emergency Medicine in Lisbon, 2021. European Journal of Emergency Medicine. 2021 Oct 1;28(5):329.

4. Vassallo JM, Smith JE, Wallis LA. Investigating the effects of under-triage by existing major incident triage tools. European Journal of Emergency Medicine. 2019 Apr 1;26(2):139-44.

5. James A, Yordanov Y, Ausset S, Langlois M, Tourtier JP, Carli P, Riou B, Raux M, TRAUMABASE Group. Assessment of the mass casualty triage during the November 2015 Paris area terrorist attacks: towards a simple triage rule. European journal of emergency medicine. 2021 Apr 1;28(2):136-43.

6. Hudson GR, Howley N, Boyle A. Can artificial intelligence and machine learning help reduce the harms of emergency department crowding?. European Journal of Emergency Medicine. 2021 Apr 1;28(2):95-6.

7. Bernstein SL, Aronsky D, Duseja R, Epstein S, Handel D, Hwang U, McCarthy M, John McConnell K, Pines JM, Rathlev N, Schafermeyer R. The effect of emergency department crowding on clinically oriented outcomes. Academic Emergency Medicine. 2009 Jan;16(1):1-0.

8. Freund Y. Eighteen months later…. European Journal of Emergency Medicine. 2021 Dec 1;28(6):409-10.

9. Freund Y. The challenge of emergency medicine facing the COVID-19 outbreak. European Journal of Emergency Medicine. 2020 Jun 1;27(3):155.

10. Kelen GD, McCarthy ML, Kraus CK, Ding R, Hsu EB, Li G, Shahan JB, Scheulen JJ, Green GB. Creation of surge capacity by early discharge of hospitalized patients at low risk for untoward events. Disaster medicine and public health preparedness. 2009 Jun;3(S1):S10-6.

11. Pollaris G, Sabbe M. Reverse triage: more than just another method. European Journal of Emergency Medicine. 2016 Aug 1;23(4):240

12. De Bondt F, Pollaris G, Sabbe MB. Can a reverse triage clinical decision support tool create sufficient surge capacity and reduce emergency department crowding?. European Journal of Emergency Medicine. 2022 Feb 1;29(1):16-7.-7.

13. Kelen GD, Kraus CK, McCarthy ML, Bass E, Hsu EB, Li G, Scheulen JJ, Shahan JB, Brill JD, Green GB. Inpatient disposition classification for the creation of hospital surge capacity: a multiphase study. The Lancet. 2006 Dec 2;368(9551):1984-90.

14. Pollaris G, Sabbe M. Reverse triage: more than just another method. European Journal of Emergency Medicine. 2016 Aug 1;23(4):240-7.

15. Pollaris G, Note S, Desruelles D, Sabbe M. Novel IT application for reverse triage selection: a pilot study. Disaster Medicine and Public Health Preparedness. 2018 Oct;12(5):599-605.

16. Barbisch DF, Koenig KL. Understanding surge capacity: essential elements. Academic Emergency Medicine. 2006 Nov;13(11):1098-102.

17. Hoot NR, Aronsky D. Systematic review of emergency department crowding: causes, effects, and solutions. Annals of emergency medicine. 2008 Aug 1;52(2):126-36.

18. Caramello V, Marulli G, Reimondo G, Fanto' F, Boccuzzi A. Comparison of Reverse Triage with National Early Warning Score, Sequential Organ Failure Assessment and Charlson Comorbidity Index to classify medical inpatients of an Italian II level hospital according to their resource's need. Internal and Emergency Medicine. 2019 Oct;14:1073-82.

19. Esmailian M, Salehnia MH, Shirani M, Heydari F. Reverse triage to increase the hospital surge capacity in disaster response. Advanced journal of emergency medicine. 2018;2(2).

20. Caramello V, Marulli G, Reimondo G, Fanto' F, Boccuzzi A. Inpatient disposition in overcrowded hospitals: is it safe and effective to use reverse triage and readmission screening tools for appropriate discharge? An observational prospective study of an Italian II level hospital. International journal of clinical practice. 2019 Mar;73(3):e13281.

21. David SS. Handbook of Emergency Medicine, 8/e. Elsevier India; 2012.

22. Satterthwaite PS, Atkinson CJ. Using 'reverse triage'to create hospital surge capacity: Royal Darwin Hospital's response to the Ashmore Reef disaster. Emergency Medicine Journal. 2012 Feb 1;29(2):160-2.

23. Lincoln EW, Freeman CL, Strecker-McGraw MK. EMS Incident Command. InStatPearls [Internet] 2022 May 18. StatPearls Publishing.

Annexes

Annex 1: Consent form

Reverse Triage in Inpatient Units - Consent Form

Patient Name: _____

Date: _____

I, _____, understand and consent to the reverse triage process that may be implemented in the inpatient unit where I am receiving care. Reverse triage is a strategy used during times of high patient volume or limited resources to prioritize patients based on their clinical condition and need for intensive care.

1. Purpose:

Reverse triage aims to ensure that patients who require immediate and intensive care receive it promptly, especially during situations when resources are limited. This process involves evaluating patients' conditions regularly and potentially transferring those who have improved or stabilized to lower acuity units, alternative care settings and discharging to home.

2. Process:

Healthcare professionals will assess my condition from my document to identify my medical information, to determine my eligibility for discharge.

3. Risk: None

I acknowledge that I have been provided with information about reverse triage in inpatient units, including its purpose, process, benefits, and risks. I am aware that this is a voluntary process, and I can refuse to participate at any moment or revoke my consent.

Patient Signature: _____

Date: _____

የፍቃድ ቅጽ

የታካሚ ስም፡ _____

ቀን፡- _____

እኔ፣ _____፣ እንክብካቤ እያገኘሁ ባለበት የታካሚ ክፍል ውስጥ ሊተገበር የሚችለውን የተገላቢጦሽ የመለያ ሂደት ተረድቼ ተስማምቻለሁ። የተገላቢጦሽ ትሪጅ ከፍተኛ የታካሚዎች ብዛት ወይም ውስን ሀብቶች ባሉበት ጊዜ ለታካሚዎች ክሊኒካዊ ሁኔታቸው እና ከፍተኛ እንክብካቤ እንደሚያስፈልጋቸው ቅድሚያ ለመስጠት ጥቅም ላይ የሚውል ስልት ነው።

1. ዓላማ፡-

የተገላቢጦሽ ሙከራ ዓላማው አፋጣኝ እና ከፍተኛ እንክብካቤ የሚያስፈልጋቸው ታማሚዎች በፍጥነት እንዲቀበሉት ነው፣በተለይም ሀብቶች ውስን ሲሆኑ። ይህ ሂደት የታካሚዎችን ሁኔታ በየጊዜው መገምገም እና የተሻሻሉ ወይም የተረጋጉትን ወደ ዝቅተኛ ክፍሎች፣ አማራጭ የእንክብካቤ መቼቶች እና ወደ ቤት መላክን ያካትታል።

2. ሂደት፡-

የጤና አጠባበቅ ባለሙያዎች የእኔን የጤና መረጃ ለመለየት፣ ለመልቀቅ ብቁ መሆኔን ለመወሰን የእኔን ሁኔታ ከሰነዴ ይገመግማሉ።

3. ስጋት፡ የለም።

በታካሚ ክፍል ውስጥ ስላለው የተገላቢጦሽ ልዩነት መረጃ እንደተሰጠኝ አምናለው፣ ዓላማውን፣ ሂደቱን፣ ጥቅሞቹን እና ስጋቶቹን ጨምሮ። በዚህ ሂደት ውስጥ መሳተፍ በፈቃደኝነት እንደሆነ ተረድቻለሁ፣ እና በማንኛውም ጊዜ ስምምነትን የመቃወም ወይም የመሰረዝ መብት አለኝ።

የታካሚ ፊርማ፡ _____

ቀን፡ _____

Annex 2: data collection tools

Table6. 1Reverse Triage Tool Leuven (RTTL) checklist

	RTTL criteria	
1	Patient is present at the hospital for an ambulant investigation or consultation	
2	Patient is admitted to the hospital for only 1 day	
3	Patient is present at the emergency department for less than 6 hours	
4	Patient is admitted to 1 of the following units:	
	Nephrology—Dialysis	
	Acute psychiatry	
	Delivery room	
	Complicated pregnancy	
	Hematological isolation	
5	Patient underwent an intervention in the prior 48 hours before an MCI in 1 of the following units:	
	Endoscopy	
	Interventional radiology	
	Operating room	
6	Patient underwent a surgical intervention that lasted more than 90 minutes	
7	Patient needs more than 5 liters oxygen per minute	
8	Patient underwent a transfusion in the prior 48 hours before an MCI	
9	Patient has a stage 3 or 4 decubitus wound	
10	Patient scores higher than 2 on at least 1 of the 6 physical components of the Katz scale for ADLs	

.

Table7. 1 KATZ INDEX OF INDEPENDENCE IN ACTIVITIES OF DAILY LIVING

Activities *POINTS (1 OR 0)*	*Independence* *(1 POINT)* *NO supervision, direction, or personal assistance*	*Dependence* *(0 POINT)* *WITH supervision, direction, personal assistance, or total care*
BATHING Points: ____	(1 point) Bathes self completely or needs help in bathing only a single part of the body such as the back, genital area, or disabled extremity.	(0 points) Needs help with bathing more than one part of the body, getting in or out of bathtub or shower. Requires total bathing.
DRESSING Points: ____	(1 point) Gets clothes from closets and drawers and puts on clothes and outer garments complete with fasteners. May have help tying shoes.	(0 points) Needs help with dressing self or needs to be completely dressed.
TOILETING Points: ____	(1 point) Goes to toilet, gets on and off, arranges clothes, and cleans genital area without help.	(0 points) Needs help transferring to the toilet, cleaning self, or uses bedpan or commode.
TRANSFERRING Points: ____	(1 point) Moves in and out of bed or chair unassisted. Mechanical transferring aides are acceptable.	(0 points) Needs help in moving from bed to chair or requires a complete transfer.
CONTINENCE Points: ____	(1 point) Exercises complete self-control over urination and defecation.	(0 points) Is partially or totally incontinent of bowel or bladder.
FEEDING Points: ____	(1 point) Gets food from plate into mouth without help. Preparation of food may be done by another person.	(0 points) Needs partial or total help with feeding or requires parenteral feeding.
TOTAL POINTS: ____	*6 = High (client independent)*	*0 = Low (client very dependent)*

* *Slightly adapted with permission from Gerontological Society of America. Katz, S., Down, T.D., Cash, H.R., et al. (1970). Progress in the development of the index of ADL. The Gerontologist, 10, 20-30.*

1

Table9. 1 Clinical intervention tool of reverse triage

Critical Interventions (CI) of Kelen, Kraus, and McCarthy and the Likelihood of a Consequential Medical Event (CME) If the CI Is Withdrawn Or Withheld

CI No.	CI	Likelihood of CME If Withdrawn Or Withheld[a]
1	CPR or defibrillation	10
2	Intubation or airway management	10
3	Major surgical procedure or operation	9
4	Cesarean section	9
5	Intravenous drugs: pressors, fluids	8
6	Oxygen dependent	8
7	Burn care	8
8	Cerebral bolt	8
9	Dialysis	7
10	Thoracostomie	7
11	Non-invasive PPV	7
12	Thrombolytic therapy	7
13	Transfusion	6
14	Other invasive procedure	6
15	Psychiatric monitoring	6
16	Cardiac catheterization	6
17	Thoracentesis	5
18	Wound care	5
19	Central line	5
20	Incision and drainage	5
21	Parenteral nutrition	5
22	Paracentesis	5
23	Vaginal delivery	5
24	Arterial line	4
25	Lumbar puncture	4
26	Cardiac monitoring	3
27	Parental pain medication	3
28	Support for ADL	3

Abbreviations: CPR, cardiopulmonary resuscitation; PPV, positive pressure ventilation; ADL, activities of daily life.

[a]Each intervention was ranked on a 10-point Likert scale for the likelihood a CME would develop if that particular intervention was withheld or withdrawn. Larger numbers mean a greater likelihood.

Table8. 1Description of Study Population by Institution

	TASH	**SPHMMC**	**ZMH**
Enrolled			
Age			
13-34			
35-44			
45-54			
55-64			
65-74			
>74			
Sex			
Female			
Male			
Admission source			
Emergency department			
Elective or direct admission			
Inpatient Units			
Medical			
Surgical			
Orthopedics			
Oncology			
Obstetrics/Gynecology			
Psychiatry			