

**“EARLY WARNING SYSTEMS: A COMPREHENSIVE APPROACH TO IMPROVING
PATIENT DETERIORATION AT A TERTIARY HOSPITAL”**

Dissertation Submitted to



The IIHMR University, Jaipur

for the partial fulfilment of the award of the degree of

Master of Business Administration (MBA)

in

Hospital and Health Management

By

Riya Ranjan

Under the Supervision and Guidance of

Dr Goutam Sadhu

**Professor and Dean- in charge
School of Development Studies, IIHMR University**

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DECLARATION BY STUDENT

I hereby declare that this dissertation “**EARLY WARNING SYSTEMS: A COMPREHENSIVE APPROACH TO IMPROVING PATIENT DETERIORATION AT A TERTIARY HOSPITAL**”

is the Bonafede record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.

Riya Ranjan

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Date: 14/05/2023

CERTIFICATE

This is to certify that **RIYA RANJAN** in partial fulfilment of the requirements for the award of the degree of MBA (Hospital and Health Management from the IIHMR University, Jaipur has successfully completed her/his internship at **MEDANTA- THE MEDICITY HOSPITAL** during February 20- May 19, 2023.

Place: Gurugram

Date: 15/05/2023

Preceptor/Head of the Organization: DR. AJAY VIKRAM SINGH

Name of the organization: MEDANTA- THE MEDICITY

CERTIFICATE

This is to certify that the dissertation titled “**EARLY WARNING SYSTEMS: A COMPREHENSIVE APPROACH TO IMPROVING PATIENT DETERIORATION AT A TERTIARY HOSPITAL**” is a record of the research work undertaken by **RIYA RANJAN** in partial fulfilment of the requirements for the award of the degree of MBA (Hospital and Health Management) from the IIHMR University, Jaipur under my guidance and supervision and his/her approach to the research study has been sincere, scientific, and analytical.

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ABSTRACT

A prospective and retrospective study was conducted at a tertiary hospital to assess the adherence to correct activation criteria for the Rapid Response Team and identification of Early Warning Signs as per hospital policy. Data was collected from medical records of patients for four months and a questionnaire was also developed to evaluate the knowledge among the nurses about early warning signs. The data collected was based on the demographic, Response rate of RRT, Average length of stay, Outcome of treatment and code orange activation criteria as per the hospital policy. This data was analyzed using SPSS and MS Excel to represent the result in the form of tables and graphs.

It was observed that during the first two months of the study, the adherence to protocol in terms of documentation, Code activation based on MEWS was around 90 per cent which improved to 100per cent on proper intervention by the end of the study. The questionnaire suggested a significant lack of knowledge among the nurses which can be improved through regular training programs.

It was noted that identifying early signs of deterioration can be beneficial in preventing unwanted outcomes of death or unplanned ICU treatment. The importance of EWS is not limited to only the identification of vital signs promptly but also provides a health care professional with ample amount of time to take a decision on further treatment of their patients. Out-of-pocket expenditure is a major problem in India and the EWS scoring system can even be associated with reduction in the financial burden that gets added upon if immediate emergency treatment is required.

Hence, the use of early warning sign scoring systems is an important strategy for improving patient care and outcomes. By identifying patients who are at risk of deterioration and facilitating timely interventions, these systems can help to improve patient safety, standardize care, and prevent adverse events.

KEYWORDS

Vital Signs Monitoring, Clinical deterioration, Early Warning Signs, Modified Early Warning Score, Rapid Response Team

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to my guide Dr. GOUTAM SADHU whose guidance, support, and expertise have been invaluable throughout my dissertation journey. His patience, insights, and encouragement have been essential in helping me navigate the challenges of this project.

I am also grateful to my industry mentor Dr. AJAY VIKRAM SINGH, for his valuable feedback and constructive criticism, which helped shape the direction of this work.

Additionally, I would like to thank my family and friends for their unwavering support and encouragement, which helped me stay motivated and focused.

Finally, I want to thank all the participants who generously gave their time and shared their experiences, without whom this research would not have been possible.

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ABBREVIATIONS

ABG	Arterial Blood Gas
AE	Adverse Events
ALOS	Average Length of Stay
AVPU	Alert, Verbal, Pain, Unresponsive
BPS	Behavioural Pain Scale
COPD	Chronic Obstructive Pulmonary Disorder
CPK	Creatine Phosphokinase
CPKMB	Creatine Phosphokinase-MB
CSF	Cerebrospinal Fluid
CVP	Central Venous Pressure
EWS	Early Warning Signs
FLACC	Face, Legs, Activity, Cry and Consolability
GCS	Glasgow Coma Scale
ICU	Intensive Care Unit
IPD	In-patient Department

MEWS	Modified Early Warning Score
NEWS	National Early Warning Score
PEWS	Paediatric Early Warning Score
qSOFA	Quick Sepsis-related Organ Failure Assessment
RBS	Random Blood Sugar
RI	Rothman Index
RRT	Rapid Response Team
SAP	Severe Acute Pancreatitis
SPSS	Statistical Sciences for Social Package
TROP-I	Troponin-I
TTS	Track and Trigger System

CHAPTER 1: INTRODUCTION

In this chapter, the early warning signs are introduced to the reader along with their significance, thus establishing the background for the need of this project. Following that, the project's goals and objectives are outlined.

1.1 BACKGROUND

The healthcare industry in India has been grappling with the rising number of inpatient deaths occurring in hospitals, with several factors such as cardiac arrest, stroke, sepsis, and other critical illnesses contributing to the mortality rate. While some of these factors may be out of control of healthcare professionals at hospitals, several factors can be managed with prompt and appropriate medical interventions.

According to the statistics from IHME (Institute for Health Metrics and Evaluation)¹, chronic heart disease, neoplasm, chronic respiratory diseases, infections such as tuberculosis (TB), chronic kidney disease, and diabetes are the top five causes of death among people over 50 years of age in India, accounting for almost half of the total deaths. This highlights the need for a comprehensive approach to healthcare management and prevention of these chronic diseases, particularly in the elderly population.

In addition to chronic illnesses, patients in hospitals may also exhibit clear signs of deterioration in vital signs or other symptoms several hours before collapsing.

These early warning signs may include changes in blood pressure, heart rate, respiratory rate, and level of consciousness.

These vital signs can be easily recorded at the bed side of the patient by nurses and healthcare professionals during routine patient visits or at regular intervals during the day. Such patients also exhibit clear signs of deterioration such as difficulty in breathing, altered mental status.

A concept of Early Warning Scoring System was developed to promptly recognise abnormal changes in these vital signs which are awarded scores based on the cut off limit. These scores act as a trigger system to activate a rapid emergency response to manage the patients clinically before a fatal progression of the condition.

Early recognition of deterioration not only helps in reducing the chances of mortality or severe complications, but also proves beneficial for the healthcare organization and the workforce. A

standardized system helps in reduction of risk which in turn helps in better resource allocation. For example, on early recognition of such warning signs, a patient can be prioritised, and resource can be allocated accordingly so that critical care is provided to those who need it the most. It also forms a proper communication system and enhance team work. An early identification of warning signs triggers an early response by the rapid response team and prompts them to collaborate to manage the patients.

Presence of a protocolised early warning response system and a designated team is imperative for a tertiary hospital setting as these hospitals see a large number of patients visiting them for various serious and fatal disease conditions. Several of these patients seek care only when a critical intervention is required and in such cases chances of deterioration and progression into adverse events like a cardiac arrest is definite.

However, hospitals face several challenges and barriers in effective implementation of the early warning sign system which not only leads to a failure in managing patients and saving lives but also leads a wastage of human and other resources. There are several factors that could be attributed to failure of proper implementation, viz., lack of manpower in wards, inadequacy of skills and knowledge among nurses, unavailability of SOPs to follow in case of an adverse event, absence of a designated Rapid Response Team to name a few.

Prompt recognition of these signs is critical, as it can prevent unexpected ICU admissions and reduce the substantial expenses associated with emergency treatments aimed at reviving the patient.

Moreover, failure to recognize these early warning signs can lead to patient mortality, underscoring the importance of early recognition and intervention.

By adopting an initiative-taking approach to patient care and using early warning systems and appropriate medical interventions, healthcare professionals can help prevent adverse outcomes and improve patient outcomes.

There are several early warning scores (EWS) systems used in hospitals, and they differ in their components and the way they calculate the scores. Here are some examples of EWS systems used in hospitals:

1. **Modified Early Warning Score (MEWS):** It is a simple bed side scoring tool which incorporates a scoring system with five parameters, viz., respiratory rate (breaths/min), heart rate (beats/min), systolic blood pressure (mmHg), temperature, and oxygen saturation. Individual score is assigned to all the parameters and total score of more than 3 prompts a trigger to call an emergency response team.

2. National Early Warning Score (NEWS): It is a similar scoring system and used extensively in the United Kingdom and several other countries. In addition to the five parameters used in MEWS, it also incorporates neurological status to calculate the total score of a patient.
3. Paediatric Early Warning Score (PEWS): This Early Warning System incorporating all the parameters as MEWS is used in case of paediatric patients. However, each parameter has different cut off level to award a score.
4. Quick Sepsis-related Organ Failure Assessment (qSOFA): It is an EWS used in cases of high risk patients identified with sepsis. It is used to identify patients who require critical care and intervention. Three main parameters used to calculate the severity are, blood pressure, respiratory rate, and mental status.
5. Rothman Index (RI): It is an early warning scoring system which is incorporated into EMR (electronic medical records). It is similar to MEWS in terms of parameters; however, it also includes lab diagnosis and nursing assessment in addition to the five vital signs.

1.1.1 DEVELOPING MEWS

Early Warning Score (EWS) system was presented by a team of three English men from the United Kingdom, namely, Wright, Morgan, and Williams in 1997. This was based on five vital parameters, viz., Systolic blood pressure, pulse rate, respiratory rate, temperature, oxygen saturation, and AVPU (Alert, Verbal, Pain, Unresponsive) response. Each parameter is assigned a specific cut off level which corresponds to different trigger scores. These scores are colour coded as well. For example, 0 is green, 1 is orange, 2 is yellow and 3 is the highest risk score with red colour coding. The concept of this scoring system was developed to identify early signs of deterioration in patient hours before they collapse into a fatal outcome by utilizing the cut off score as a track and trigger system (TTS). Since then, it has been modified and standardized as per the policies of a hospital.

A modified version (MEWS) and (PEWS) of the early warning score (EWS) is used at Medanta Hospital as a bedside tool to identify any deterioration in the vital signs of a patient. The score sheet includes Supplemental O₂ and Glasgow coma scale (GCS) in addition to the five vital parameters, which are Respiratory Rate (Breaths/Min), Oxygen Saturation (SpO₂%), Temperature (in Fahrenheit), Systolic Blood Pressure (mmHg), and Heart Rate (beats/ minute).

Every Patient admitted in wards are visited at regular intervals by nurses assigned on duty and they record the vital signs in the MEWS score sheet attached in the medical records of the patients. The sheet also monitors intake (orally, IV fluids) as well as output (urine, bowel, aspiration) of fluid on hourly basis.

Early Warning Sign scoring system proves to be a simple and cost effective tool if used efficiently, however, the true benefits are not realized in practise in a hospital setting. Lack of adequate staff per patient, inadequate skills decision making, improper communication, unfamiliarity to hospital protocols, are some of the reasons that could be attribute to ineffective implementation of this scoring system. These barriers not only cause a failure in proper management and patient care but also leads to a substantial loss of resources of the organization. Multi-speciality hospitals where the average footfall of patients turns out in thousands can enjoy maximum benefits out of this system. But, to maintain the proper functioning and implementation, regular checks, and capacity building should be administered.

Hence, study was conducted to assess the current practise and the level of effectiveness of Modified Early Warning scoring system for both adult and paediatric patients admitted in wards and day care in the hospital.

1.1.2 AIMS AND OBJECTIVES

Aim:

To evaluate the accuracy of code orange activation criteria with adherence to the Early Warning Signs identification protocol

Objectives:

1. To determine the percentage of cases of code announced as per MEWS Score more than 4 during code.
2. To evaluate determine the compliance of percentage of cases of code announced with correct per and post event documentation
3. To assess the compliance to Arrival of RRT on code activation time of the code orange team within 15 mins.
4. To determine the level of awareness about Early Warning Signs and code orange activation among nurses deployed in IPDs and Day care.

CHAPTER 2: REVIEW OF LITERATURE

The need for a systematic approach to detecting and responding to patient deterioration before critical events propelled the development of the concept of Early Warning Signs. This concept arose from the recognition that subtle physiological changes can serve as early indicators of a patient's deteriorating condition. By implementing a simple yet effective bedside tool, healthcare professionals can identify these signs, sometimes hours before a fatal collapse occurs. This early detection enables timely interventions and enhances the clinical management of critical conditions, ultimately improving patient outcomes. Early Warning Signs have proven to be invaluable in healthcare practice, empowering medical teams to proactively address potential emergencies and provide the necessary care to patients in need.

An Early Warning Score System was developed for the first time in 1997 by Williams and Wright in the United Kingdom which incorporated five physiological parameters like heart rate, blood pressure, temperature etc. Each of the parameters were assigned scores based on cut off points which served as a track and trigger system. This was used to call upon an outreach team called as rapid response team. Since then, it has been modified and standardized by various hospitals as per their own policy. MEWS has been identified as an important tool in saving patient lives by healthcare professionals.

In their study, by Amena Khan et al², MEWS has been identified as a reliable indicator which is not only prognostic but also dynamic score that reflects deterioration of patients with acute pancreatitis into SAPs. They measured the outcome in terms of two parameters, highest MEWS of the day (hMEWS) and mean of total MEWS score (mMEWS). It was observed in their study that the accuracy of hMEWS greater than 2 and mMEWS greater than 1.4 was more than other studies done with similar objectives but different systems like APACHE assessment.

A retrospective study on 200 patients by Jerone Ludikhuize et al³ emphasises on the fact that vital signs can be an effective way to identify deterioration several hours before it appears clinically. It was observed in the study that around 81 percent of the cases had a MEWS score of 3 or more before 48 hours of a fatal collapse at least once. Similarly in a study conducted at Easton Hospital⁴ to introduce a MEWS system showed that there was an increase in percent of Rapid Response Team, however, it led to decline progression of a case to code blue or death. It was also seen that there was a decline in RRT cases that were transferred to ICUs for higher level of care. This leads to improved patient care, better clinical outcome, and lower rates of mortality. Several scoping and systematic reviews^(5,6), have shown similar results on implementation of early warning scoring

system in paediatric patients as well. PEWS score was found out to be valid and accurate in identifying children with higher level of critical illness and associated with lower mortality and code rates.

However, hospitals face numerous challenges when it comes to implementing the Modified Early Warning Score (MEWS) system. In their studies, Shamsa Samani et al. and John Asger Petersen ^(7,8) have identified various factors that hinder the detection of early warning signs and act as barriers to the proper and effective implementation of Early Warning Systems (EWS). One of the primary obstacles identified is the non-adherence to protocols regarding the frequency of monitoring vital signs. Another significant contributing factor to the failure of early warning sign system implementation is the lack of communication between doctors and the emergency response team. These challenges can be attributed to understaffing, which results in overburdened healthcare professionals and long working hours. Furthermore, the lack of clinical knowledge among nurses exacerbates the issue since nurses are the primary point of contact for patients with both doctors and the hospital.

Ongoing training using simulations, mock drills, role play, and similar methods can effectively enhance the skills and capabilities of nurses. By providing on-the-job training specifically focused on recognizing vital signs and identifying patient deterioration, the overall knowledge and expertise of nurses can be significantly improved. These training methods serve a dual purpose: boosting nurses' confidence in their work and sharpening their critical thinking abilities. In healthcare settings, where even the slightest oversight can have fatal consequences for patients, cultivating a critical thinking mindset is crucial. By ensuring that nurses are well-prepared to identify subtle changes in patient conditions, these training approaches contribute to better decision-making and enhance patient outcomes.

A significant obstacle in promptly and accurately identifying and recording vital signs is the shortage of staff, which results in nurses being overworked. In hospitals across India, there is an insufficient patient-to-nurse ratio, with each nurse having to attend to approximately 5-6 patients simultaneously. This situation leads to divided attention among nurses and frequent interruptions while conducting regular vital sign monitoring for each patient.

Several difficulties are faced by nurses in providing comprehensive critical care to patients which are aggravated by a shortage of staff in the hospital. An adequate nurse to patient ratio leads to divided attention and time of the nurses while recording the vital signs of each patient. With an increased workload it is likely for the nurses to overlook or miss the identification of subtle changes or abnormal trends in vital signs, consequently leading to delayed interventions.

Interruptions, due to high patient load, for example, phone calls, calls and requests by other patients or their attendants, colleagues, or doctors during recording of vital signs can lead to inaccurate scoring. This not only disrupts the flow of monitoring but also affects efficient decision making and diligence during observation. Chiara Dall'Ora et al.⁹ conducted a study to assess the time taken to record a set of vital signs for a patient. It was estimated that around 5 minutes 1 second was required to record a set of vital signs for an individual patient. However, this could increase by more than a minute to around 6 minutes 26 second by including various interruptions.

In order to get past these barriers, addressing the shortage of staff is primarily important leading to an increase in the patient to nurse ratio. An adequate nursing workforce would help in increased focus and attention towards each patient. Consequently, leading to proper and thorough monitoring and correct identification of deterioration. Additionally, a supportive and uninterrupted work environment would also increase the accuracy and reliability of the recorded vital signs.

A hospital should realize the importance of optimum level of staff and reduced interruption to augment the level of patient safety and improved health of the patients.

Timely and effective identification of vital signs and symptoms can be improved by adequate resource planning and allocation to reduce the burden on nurses as well as enable them to provide quality and optimal care.

Recent times have seen several advancements in technology in healthcare sector as well which not only benefits the industry but improve the quality of care. Electronic methods employed in hospitals reduces the workload on health care providers by reducing the requirement of manual work like data entry as well as enhances communication between the team. A study related to implementation of technology at work place found out that the time of contact between patient and doctors increased by twice the time spent earlier. Additionally, it can also be utilized by nurses to monitor vital signs of the patients admitted in wards. This will reduce the workload of the nurses and also curtail the risk of overlooking crucial signs of deterioration among patients.

Stephanie Soon et al.¹⁰ conducted a study to examine various technologies and identified thirty distinct types of wearable devices developed to assist healthcare professionals in monitoring vital signs. These were chest straps, wrist bands, clothing-based patches, and arm bands. While some gaps are identified in the existing literature regarding the effectiveness of these wearable devices, they still prove to offer considerable opportunity for improving the accuracy and frequency of monitoring of vital signs of patients in hospital wards.

Lastly, the implementation of an early warning sign system proves to have a pivotal role in healthcare settings. By punctually identifying and monitoring changes in vital signs, early warning signs system enables healthcare providers to act at an early stage and prevent progression of an adverse outcome. The use of advanced technology and wearable devices additionally enhances the

effectiveness of such systems, allowing for continuous monitoring and early intervention for better clinical management and prognosis. This not only improves patient safety but also reduces the burden on healthcare professionals by providing a driven approach to patient care. Emphasizing the importance of early detection and response, these systems contribute significantly to improving patient outcomes and enhancing the overall quality of healthcare delivery.

CHAPTER 3: METHODOLOGY

This Chapter provides the readers with a detailed explanation of how the data was collected and analysed. It allows the reader to understand the research design, the population studied, the sampling methods used, and the data collection and analysis techniques employed.

3.1 RESEARCH QUESTION

Is the implementation of the activation criteria for Code orange carried out correctly and in compliance with the Early Warning Signs policy at Medanta Hospital?

3.2 RESEARCH DESIGN

It involves the overall strategy applied and plan of action used to address the research question and objectives of the study.

3.2.1 STUDY SETTING

This study was conducted at Medanta-The Medicity Hospital, a multi-specialty hospital with 1250 beds and approximately 40 specialties, located in the Delhi/NCR region. The study was conducted under the guidance of Head, Quality department, of the hospital and spanned from March to April of 2023.

3.2.2 RESEARCH APPROACHES

The study undertaken was a retrospective and prospective cross-sectional study in a tertiary hospital in India. It was a quantitative study with a sample size of $n = 56$ which was collected during January, 2023- April, 2023. The inclusion criteria were all in-patients (adult or paediatric) for whom a code orange was activated based on bedside MEWS score calculation. Code orange cases that were later escalated into Code Blue were also excluded from the study. Also, code orange mock drills were excluded from the study. The Sample size was determined according to the following formula¹¹:

$$n = N / (1 + Ne^2)$$

where n = number of samples, N = Total population, e = error tolerance)

By using 95% confidence level (margin of error = 0.05)

Sampling technique employed for this study was simple random sampling, wherein every individual in the population is ensured an equal chance to get selected in the sample, and the selection is made randomly.

Data was collected from MEWS and PEWS Score sheet and Progress Sheet in the medical records of the patients. Both Adult (MEWS) and Paediatric (PEWS) score sheets found in the IPD flow sheet consists of five parameters, that are: Respiratory rate, SpO2 %, Heart Rate, Temperature, Blood Pressure. Along with these the sheet also includes Glasgow Coma Scale and Supplemental Oxygen. Different ranges for each parameter are colour coded as per the score. For example, the respiratory rate of 12-20 breaths/ minute is colour coded green with a score of 0 and ≥ 25 breaths/ minute is red with a score of 3. PEWS sheets are also of three different types for different age groups which are 0-12 months, 13 months- 8 years, and above 8 years. These sheets have different colour coding and ranges as compared to the MEWS sheet. For example, the respiratory rate of 30-35 breaths/ minute in a patient of age group 0-12 months is colour coded white with a score of 0 and respiratory rate ≥ 80 breaths/ minute is coded pink with a score of 3. Ranges for the vital parameters also differ according to the age group of the PEWS Sheet.

MEWS							
Modified Early Warning Score (MEWS)							
Score	3	2	1	0	1	2	3
Respiratory rate		< 9		9 - 14	15 - 20	21 - 30	> 30
Saturation rate (with therapy)	< 90						
Heart frequency		< 40	40 - 50	51 - 100	101 - 110	111 - 130	> 130
Systolic blood pressure	< 70	70 - 80	81 - 100	101 - 200			
Temperature		< 35.1	35.1 - 36.5	36.5 - 37.5	> 37.5		
Consciousness				A	V	P	U
Urine production	< 75mL in the last 4 hours						
Nurse being worried	1 point						
A = Alert V = Response to verbal stimulation P = Response to painful stimulation U = Unresponsive							
RIT protocol							
1. Determine MEWS → MEWS ≥ 3 contact clinician on duty							
2. Clinician on duty assess patient < 30 min and draft a plan for treatment							
3. Effect of treatment is analyzed < 60 min							
4. If no effect of treatment → clinician on duty contacts RIT							
5. If not complied with 2,3,4 → clinician on duty or nurse contacts RIT							
6. Document aberrant parameters in the patient' charts							

Figure 1 :MEWS scoring system

Adapted from A Protocolised Once a Day Modified Early Warning Score (MEWS) Measurement Is an Appropriate Screening Tool for Major Adverse Events in a General Hospital Populatio. PLOS ONE. 2016 August; 11(8).

Score Calculation

Aggregate MEWS is calculated based on scores filled in the MEWS sheet for the various parameters. Score awarded against each parameter is added together to get the final score. Subsequently, a nurse or a health professional based on the score and their judgment takes the decision to activate a code orange. An aggregate score of 5-6 is the key threshold for urgent response which is required to activate code orange. This is clinically determined as medium risk and the patient is to be monitored at a frequency of 30 minutes. Once a code is activated a Rapid Response Team (RRT) arrives at the location and tries to clinically manage the patient's condition.

Rapid Response Team Composition

For Adult Patients

- a) Critical Care on Call – Team leader
- b) Nursing Supervisor
- c) Security Personnel

For Paediatric Patients

- a) Paediatric ICU Doctor on Duty – Team leader
- b) Nursing Supervisor
- c) Security Personnel

DECIPHERING MODIFIED EARLY WARNING SCORE (MEWS)

- MEWS Score not applicable for below mentioned group:
1) Children below 18 years 2) COPD Patients 3) Pregnant woman
- Sudden deterioration in Neurological status as per GCS, CODE ORANGE to be announced
- Systolic BP should be taken for MEWS score calculation.

Aggregate MEWS score	Clinical risk	Response	Action	Frequency of monitoring
Aggregate score 0-4	Low	Ward based response	Inform to Floor doctor, TL	4 hourly
Red score 3 (score of 3 in any individual parameters)	Low-Medium	Urgent ward based Response	Inform to Doctor on call from treating team, Floor doctor, TL, Nursing Supervisor	1 Hourly
Aggregate score 5-6	Medium	Key threshold for urgent response	Inform to Doctor on call from treating team, admitting doctor if possible. Announce CODE ORANGE immediately.	30 Minutes
Aggregate score 7 or more	High	Urgent or emergency Response	CODE BLUE	Continues

Figure 2: Code orange activation criteria for adult patients

DECIPHERING PEDIATRIC EARLY WARNING SCORE (PEWS)

PEWS Should use in acute pediatric health care settings for the detection of, and timely response to, clinical deterioration in children (Including Neonates)

- PEWS Score not applicable for below mentioned group:
1) Age >1 year 2) COPD Patients
- Sudden deterioration in Neurological status as per GCS, CODE ORANGE to be announced
- Systolic BP should be taken for PEWS score calculation.

Aggregate PEWS score	Clinical risk	Response	Action	Frequency of monitoring
Aggregate score 0-4	Low	Ward based response	Inform to Floor doctor, TL	4 hourly
Pink score 3 (score of 3 in any individual parameters)	Low-Medium	Urgent ward based Response	Inform to Doctor on call from treating team, Floor doctor, TL, Nursing Supervisor	1 Hourly
Aggregate score 5-6	Medium	Key threshold for urgent response	Inform to Doctor on call from treating team, admitting doctor if possible. Announce CODE ORANGE immediately.	30 Minutes
Aggregate score 7 or more	High	Urgent or emergency Response	CODE BLUE	Continues

Figure 3 : Code orange activation criteria for paediatric patients (0-12 months)

DECIPHERING PEDIATRIC EARLY WARNING SCORE (PEWS)

PEWS Should use in acute pediatric health care settings for the detection of , and timely response to, clinical deterioration in children(Including Neonates)

- PEWS Score not applicable for below mentioned group:
1) Age <12 months and > 8 year 2) COPD Patients
- Sudden deterioration in Neurological status as per GCS, CODE ORANGE to be announced
- Systolic BP should be taken for PEWS score calculation.

Aggregate PEWS score	Clinical risk	Resoponse	Action	Frequency of monitoring
Aggregate score 0-4	Low	Ward based response	Inform to Floor doctor, TL	4 hourly
Pink score 3 (score of 3 in any individual parameters)	Low-Medium	Urgent ward based Response	Inform to Doctor on call from treating team, Floor doctor, TL, Nursing Supervisor	1 Hourly
Aggregate score 5-6	Medium	Key threshold for urgent response	Inform to Doctor on call from treating team, admitting doctor if possible. Announce CODE ORANGE immediately.	30 Minutes
Aggregate score 7 or more	High	Urgent or emergency Response	CODE BLUE	Continues

Figure 4: Code orange activation criteria for paediatric patients (13months-8 years)

DECIPHERING PEDIATRIC EARLY WARNING SCORE (PEWS)

PEWS Should use in acute pediatric health care settings for the detection of , and timely response to, clinical deterioration in children(Including Neonates)

- PEWS Score not applicable for below mentioned group:
1) Age 0 to 8 years 2) COPD Patients 3) Adults
- Sudden deterioration in Neurological status as per GCS, CODE ORANGE to be announced
- Systolic BP should be taken for PEWS score calculation.

Aggregate PEWS score	Clinical risk	Response	Action	Frequency of monitoring
Aggregate score 0-4	Low	Ward based response	Inform to Floor doctor, TL	4 hourly
Pink score 3 (score of 3 in any individual parameters)	Low-Medium	Urgent ward based Response	Inform to Doctor on call from treating team, Floor doctor, TL, Nursing Supervisor	1 Hourly
Aggregate score 5-6	Medium	Key threshold for urgent response	Inform to Doctor on call from treating team, admitting doctor if possible. Announce CODE ORANGE immediately.	30 Minutes
Aggregate score 7 or more	High	Urgent or emergency Response	CODE BLUE	Continues

Figure 5 Code orange activation criteria for paediatric patients (8 years and above)

Data was collected for following parameters:

- Demographics (Age, Sex)
- Time of activation of code orange
- Time of arrival of the RRT (Rapid Response Team)
- MEWS score
- Reason for code activation
- Final outcome of treatment

- ALOS (Average Length of stay)

A questionnaire was also developed to assess the level of awareness about Early warning signs and Code Orange activation among nurses deployed in wards and day care. It consisted of ten questions with multiple options to assess the knowledge of protocol to activate a code orange as well the fluency with identifying and recording vital signs for MEWS. A sample size of n=132, nurses was taken to conduct the survey regarding the level of awareness and technique applied was simple random sampling. Sample size for nurses was calculated using the formula:

$$n = \frac{N}{1 + Ne^2}$$

where n= number of samples, N= Total population, e= error tolerance)

By using 95% confidence level (margin of error= 0.05)

Early Warning Signs

Early warning signs in a hospital typically refer to a set of physiological indicators that healthcare providers monitor to identify patients who may be at risk of deteriorating or experiencing clinical deterioration. These signs may include changes in a patient's vital signs, such as heart rate, respiratory rate, blood pressure, and temperature, as well as changes in their level of consciousness, oxygen saturation, and urine output.

MEWS

MEWS stands for Modified Early Warning Score. It is a scoring system used in healthcare settings to assess the severity of a patient's condition and to identify those at risk of clinical deterioration. The MEWS score is based on a patient's vital signs, including respiratory rate, heart rate, blood pressure, temperature, and level of consciousness. Each vital sign is assigned a score, and the scores are added together to calculate the patient's overall MEWS score.

Rapid Response Team (RRT)

The rapid response team (RRT)—sometimes referred to in the literature as a medical emergency team—is a team of nurses and other health care professionals (respiratory therapists, pharmacists, emergency department personnel, and others) who bring critical care expertise to

the bedside. The key goal is to act before “failure to rescue” occurs and a patient has suffered a cardiac or respiratory arrest.

The collected data was analysed using descriptive statistics to assess the accuracy of the criteria used to activate Early Warning Signs and adherence to hospital protocols using SPSS. It was also used to evaluate the answers marked by nurses in the questionnaire. The data was also analysed and presented in the form of tables, charts, and graphs using MS Excel.

3.2.3 ETHICAL CONSIDERATION

The proposed research conforms to the consent given by participants regarding data collection. However, any confidential information that may potentially reveal the participants' identities were safeguarded to prevent any unintended consequences. To ensure that the study does not violate any copyright laws, proper attribution and referencing was given in the research. This was done with an aim to maintain the integrity of the research while also protecting the privacy of the participants and ensuring that their rights are respected.

CHAPTER 4: RESULTS

This section provides the readers a clear and concise summary of the data collected, analysed, and interpreted to answer the research questions for easy understanding.

4.1 DEMOGRAPHIC PROFILE OF PATIENTS

Data was collected based on the demographic details in terms of Age, Sex. Around three fourth of code orange activated was for Males (65.2 percent) and only 30.2 percent patients were females. The mean age was 62.6 years with a standard deviation of 14.54. It was observed that the age group between 50- 60 years had more chances of fatal outcomes like death.

The result for the first two months (January'23- February'23) depict the data for the period before implementation of the intervention. March'23 and April'23 depict the result of the impact of intervention.

4.2 MEWS BASED CODE ACTIVATION

As per the policy, an aggregate MEWS score of 3 is considered as the threshold to activate a code to prompt the rapid response team. A score of 0 to 2 should be managed in the wards by the assigned nurses and duty doctors. However, before the implementation of interventions, it was observed that in only around half of the cases (60 percent), where a code orange was activated, was based on the aggregate MEWS score of 4 or more. This improved to full compliance in second phase of the study by 100 percent code activation based on correct score.

4.3 COMPLIANCE TO MEWS SCORE DOCUMENTATION

A proper MEWS score documentation, including correct measurement and recording of the vital signs is an important step in effective implementation of the scoring system. This not only helps in enhanced communication during handover of the patients to nurses or change in shifts of duty doctors but also helps in predicting better prognosis of the treatment. It was observed to be followed in around four-fifth (80 percent) of the cases earlier and later improved to full compliance with 100 percent of the code orange cases with proper documentation in medical records.

4.4 TURN AROUND TIME OF RAPID RESPONSE TEAM

A rapid response team is expected to arrive at the location of patient within 15 minutes of activation of the code. This is done to prevent the condition of the patient from progressing into a cardiac arrest and consequently arising a need for code blue activation leading to immediate critical intervention in ICU. During January 2023- February 2023, it was observed that in around 90 percent of the cases, the rapid response team arrived within the time compliant to the policy, which improved to 100 percent after regular audits and mock drills were conducted.

4.5 COMPLIANCE TO DOCUMENTATION OF POST CODE EVENTS BY RAPID RESPONSE TEAM

After a code orange is announced, a patient is either shifted to ICU or managed in the ward itself depending on the level of deterioration. However, proper documentation of all the procedures after the announcement of a code is important and helps in deciding further course of treatment and prognosis. It was seen to be followed in 90 percent of the cases before intervention and improved to full compliance later in the next two months.

Additionally, the data was collected for parameters like, final outcome of the treatment and average length of stay and the results are as follows:

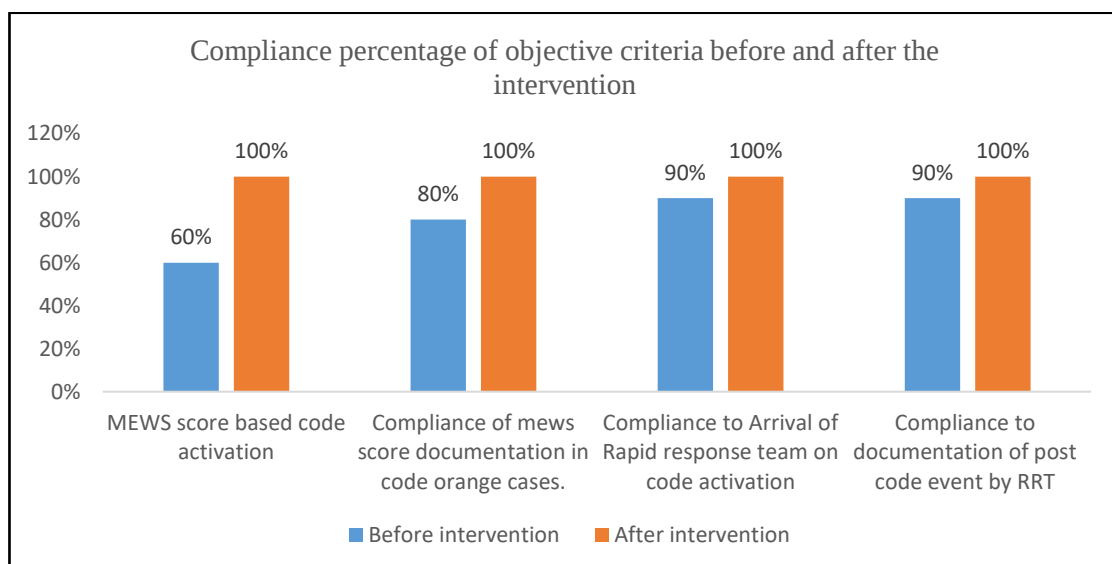


Figure 6: Comparison of result before and after implementation of intervention (n=56)

4.6 FINAL OUTCOME OF TREATMENT

An effective implementation of early warning scoring system is associated with a decline in fatal outcomes of a treatment such as cardiac arrest or death. It also leads to better management of the patient in wards and a decline in the average length of stay at the hospital. The study conducted exhibited that around half (49 percent) of the cases were clinically managed, and the patients were consequently discharged. Around one-third (27 percent) of the cases resulted into an ultimate end for the patient into death.

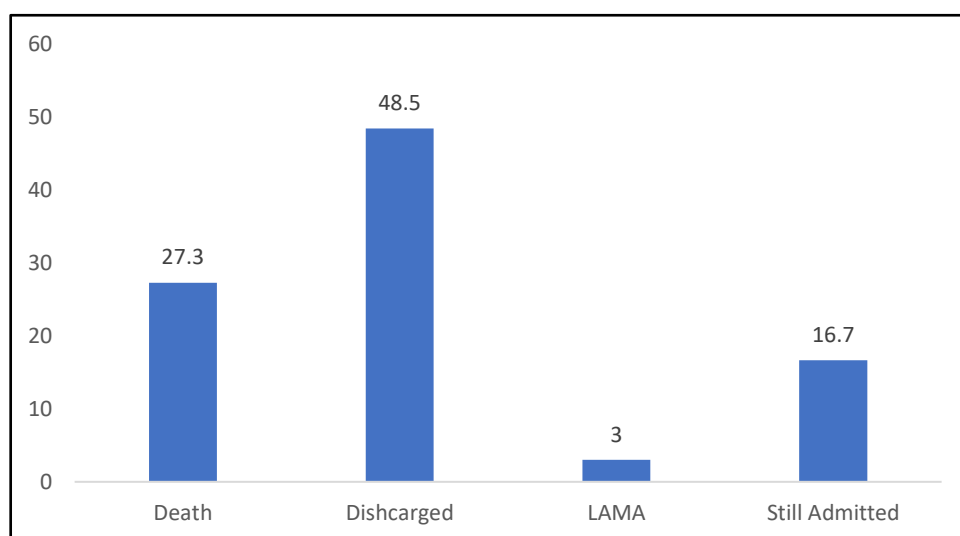


Figure 7: Final Outcome of clinical management after code activation (n=56)

Comparison of the status of patients' final treatment outcome before and after intervention:

On comparing the status of the outcome before and after implementation of interventions, the percentage of cases resulting in death showed a slight improvement with a decline of 9 percent. However, a decline in the percent of discharge cases were also seen to reduce and only three percent of the patients had prolonged stay at the hospital during the second phase of the study.

Status	Jan-Feb'23 (in %)	Mar-Apr'23 (in %)
Death	19	10
Discharge	34	16
LAMA	3	0
Still Admitted	15	3

Table 1: Comparison between status of final outcome (n=56)

4.7 ALOS (Average Length of Stay)

The mean of ALOS (Average Length of Stay) was 17.02 days with a standard deviation of 27.14. The frequency of length of stay was 9 days. 3 of the patients were still admitted hence, ALOS could not be calculated for them.

A questionnaire was developed to assess the level of awareness among the nurses regarding early warning signs and code orange activation. It was done both as an intervention and a study tool to take further measures to improve the implementation of code orange in the hospital. The results are as follows:

4.8 LEVEL OF AWARENESS REGARDING EARLY WARNING SIGNS AND CODE ORANGE ACTIVATION

Activation of an emergency response leading to a code orange activation is done in cases where a deterioration of condition is identified in patients, and it is the foremost important criteria to be remembered by all the deployed nurses and healthcare professionals.

Activation of a code for any other reason leads not only wastage of resources but also cause fatal outcomes for other patients who are actually need critical care. It was observed that more than half (85 percent) of the nurses had a correct knowledge of the reason to activate code orange in a hospital.

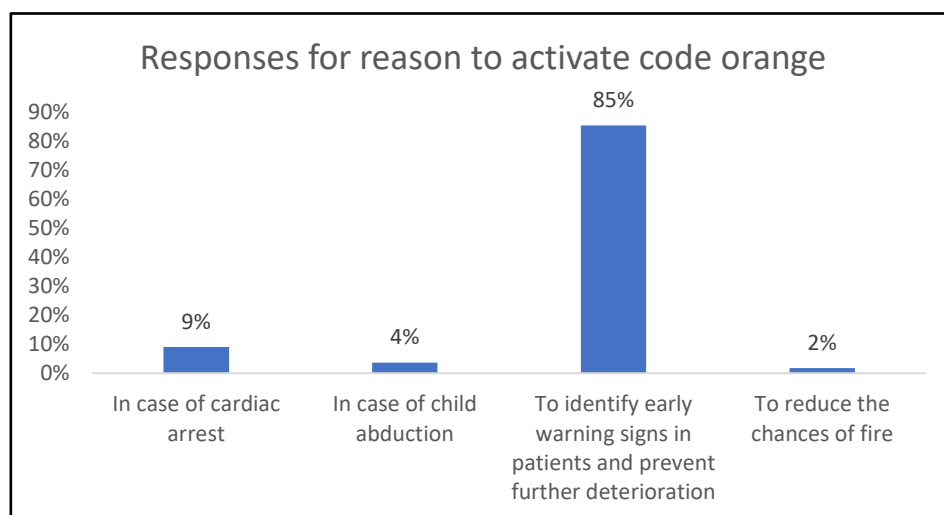


Figure 8: Reason to activate code orange (n=132)

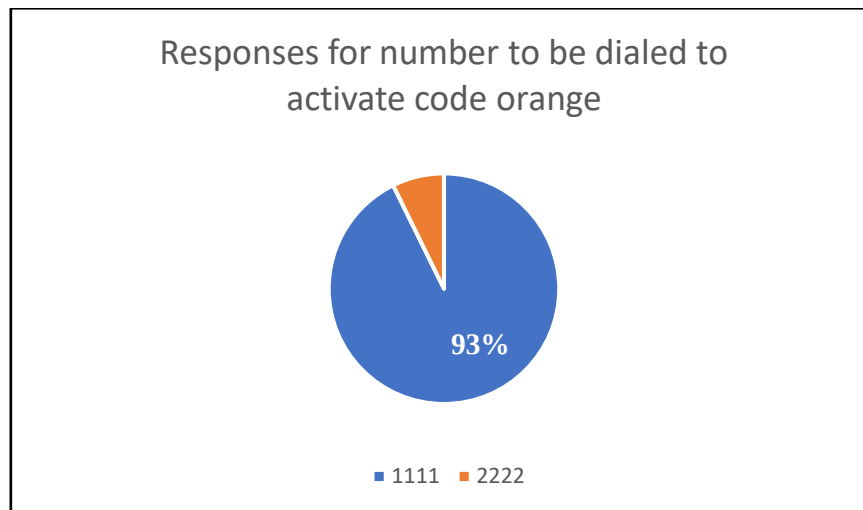


Figure 9: Correct number to dial to announce a code orange (n=132)

A standardized protocol of a designated number and code for certain adverse events reduces the chances of confusion among the healthcare professionals. Hence it is imperative that all the nurses have the knowledge of the correct number to be dialled whenever a code activation is required to not only prevent confusion but also save the precious time required to manage a patient progressing into a critical condition. It was observed that all (93 percent) of the nurses at the hospital knew the correct number for announcing code orange.

As per the hospital protocol a code orange can be activated only in wards and day care as OPD, and ICUs already have a presence of a team of physicians and specialists who are dedicated towards the patient admitted only at that location. IPDs and day care have designated shifts for duty doctors. Hence code orange is to be activated only in these locations to prompt an emergency response by the assigned team. However, contrary to the policy, it was observed that around half (56 percent) of the nurses had a wrong knowledge about the locations from where code orange could be activated. Only one-fourth(25 percent) of the nurses answered the question correctly about the location as IPD/ Day care.

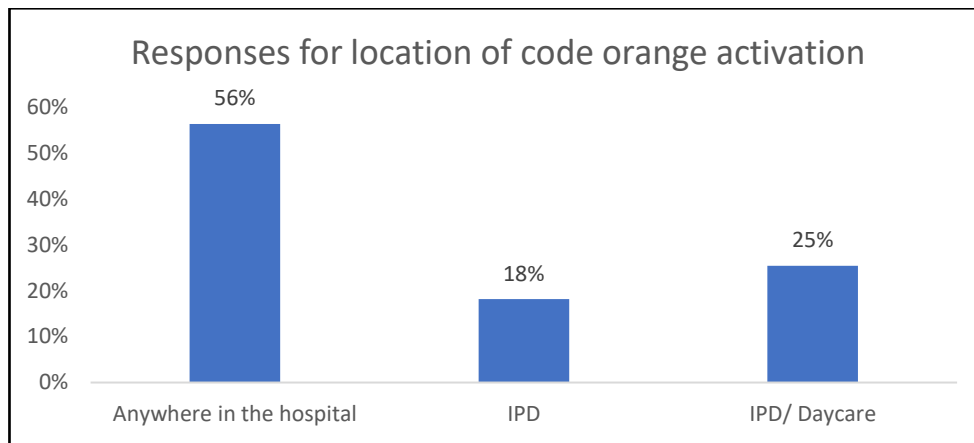


Figure 10: Location to activate code orange in the hospital (n=132)

As per the hospital policy, a code orange could only be activated if a patient has an aggregate MEWS (Modified Early Warning Score) of 5-6. Majority of the nurses (87 percent) had a correct knowledge of activation based purely on the patient's MEWS score.

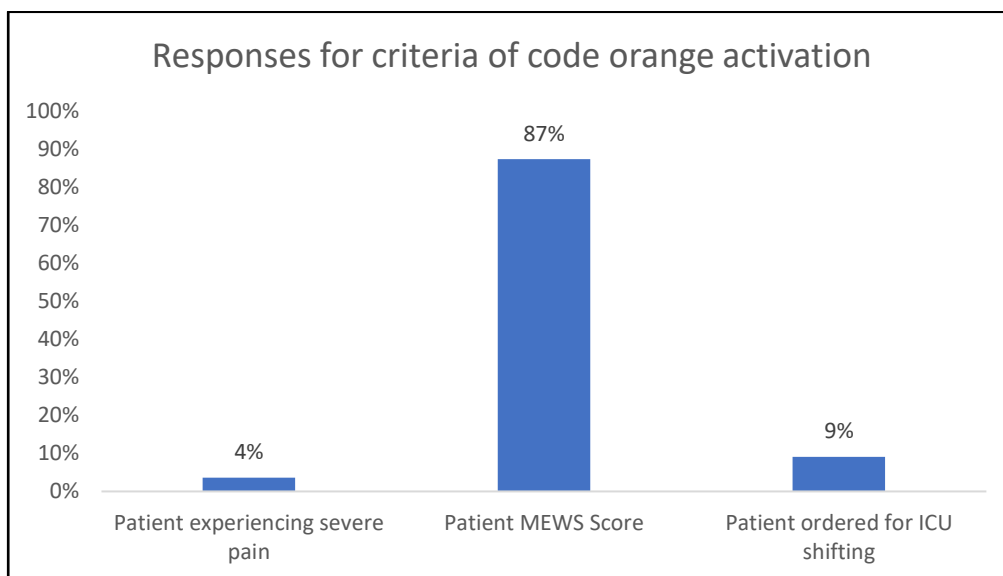


Figure 11: Criteria to activate code orange correctly (n=132)

In addition to the knowledge of MEWS score as a criterion for code activation, it is also important that the nurses have the knowledge of threshold score for code activation. The hospital policy suggests that an aggregate score of 5-6 is required for code activation and it was observed that more than two-thirds (73 percent) of the nurses had a correct knowledge of the threshold MEWS score to activate a code if a patient collapses in the ward.

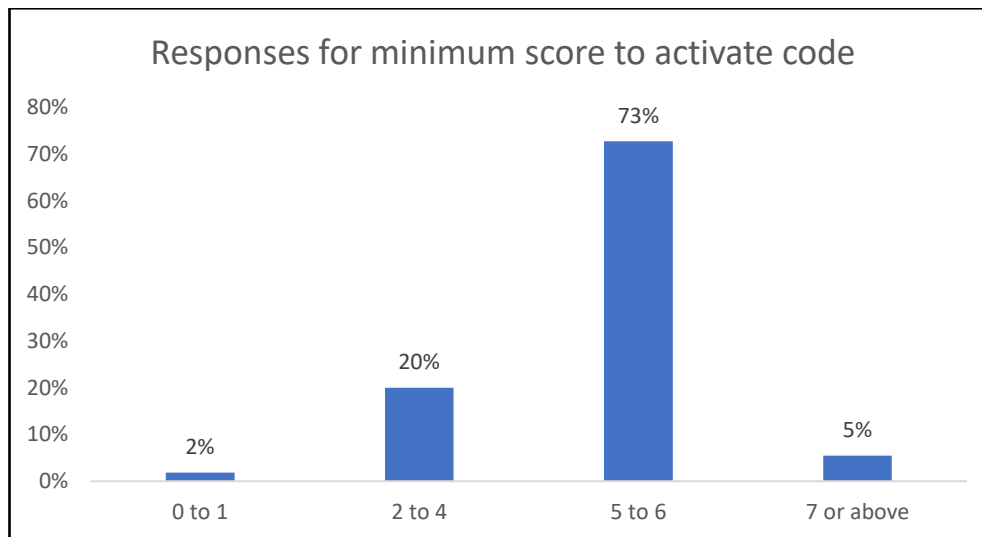


Figure 12: Minimum score to activate code orange (n=132)

Only half of the nurses at the hospital knew that MEWS (Modified Early Warning Score) was not the system to be used for paediatric patients.

However, out of these only one-third of the nurses reported the correct early warning score used in paediatric patients to be PEWS (Paediatric Early Warning Score) while half of the nurses could not recall the correct scoring system in case of paediatric patients.

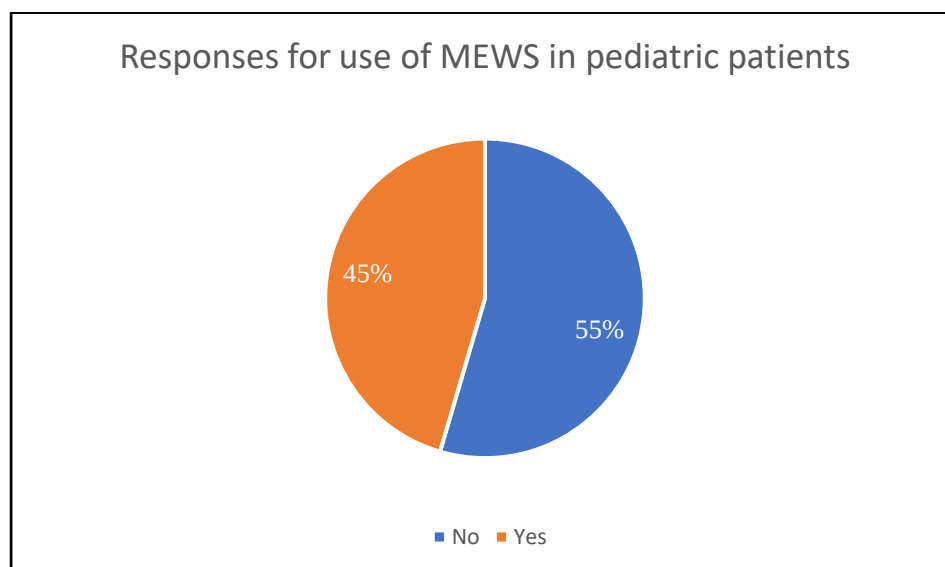


Figure 13: Early Warning Signs for paediatric patients (n=132)

Response for scoring system used in paediatric patients	Percentage
APGAR score	2
FLACC	4
NEWS	6
PEWS	33
YES	2
Cannot Recall	55

Table 2: Responses of nurses towards correct scoring system to be used in paediatric patients (n=132)

Around two thirds of the nurses knew the correct time of response taken to arrive by the Rapid Response Team. However, only one fourth of these nurses had a correct knowledge of about the subsequent step to be followed in case the Rapid Response Team does not arrive in time.

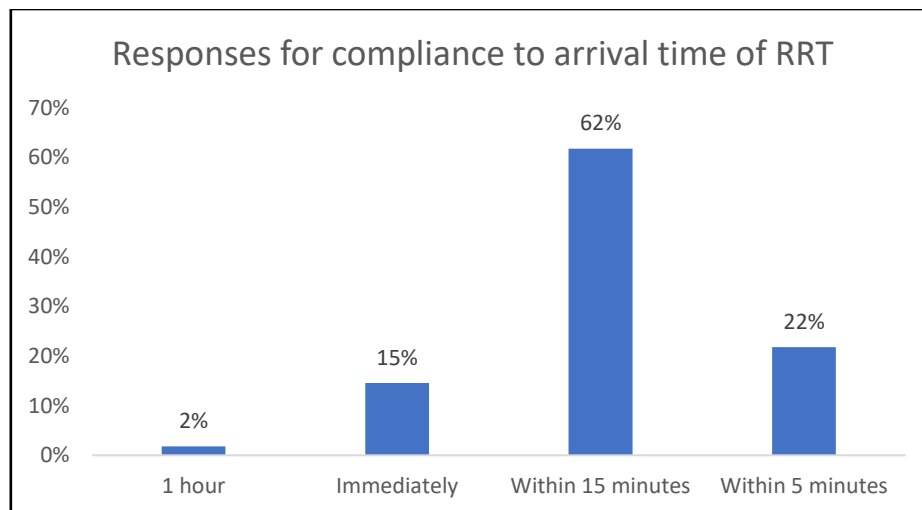


Figure 14: Response time of arrival of RRT (n=132)

Protocol to follow if RRT does not arrive in time	Percentage
Announce code blue	25
Inform treating physician	13
Shift the patient to ICU	55
Wait for Team to Arrive	7

Table 3: Response of nurses for subsequent steps if RRT does not arrive on time (n=132)

Glasgow coma scale is used to assess the neurological status of a patient. This also helps in early identification of deterioration as several patients have shown altered mental status before collapsing into a fatal condition. It was observed that only half (42 percent) of the nurses had a correct idea of the hospital policy regarding activation of code orange based on a fall in (GCS) Glasgow Coma Scale.

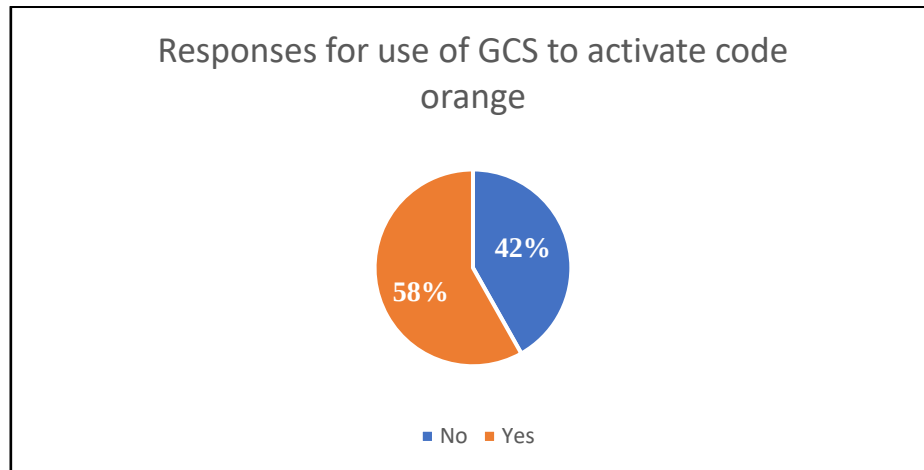


Figure 15: Activation of code based on GCS (n=132)

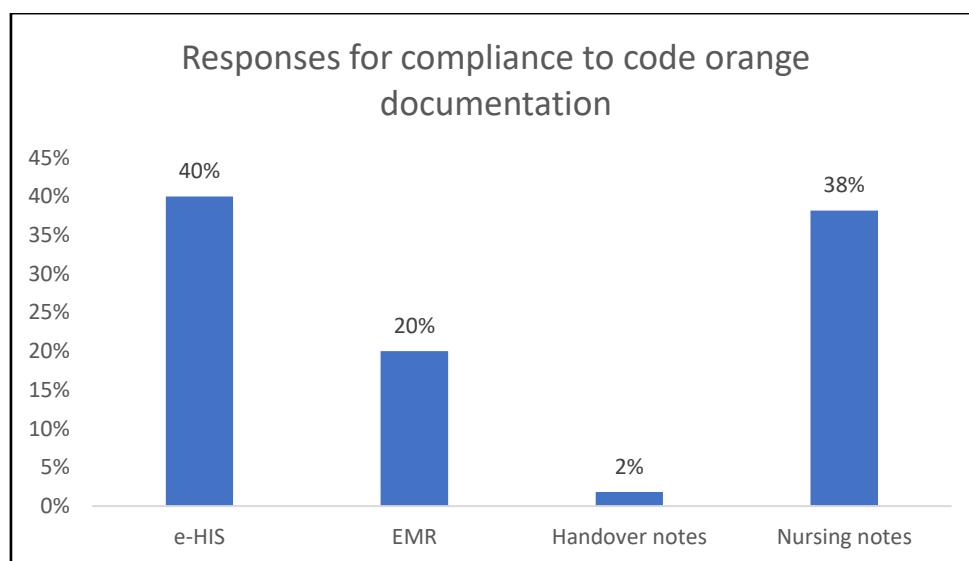


Figure 16: Documentation of a code orange activation (n=132)

Regarding the correct practise of documentation of the event post activation of a code orange, around 40 percent of the nurses followed the protocol to document the event on e-HIS (electronic-Health Information System).

Analysis of the result based on the data collected suggests several factors that influence changes in the current scenario and practise at the organization.

- Compliance to MEWS score of 5 or more to activate code orange in the hospital would not only the chances of wastage and unnecessary admission of patients into ICUs but also help in mitigation of fatal outcomes in timely manner with ease.
- The level of knowledge among the nurses regarding early warning signs suggest a need for proper educational programmes and mock drills to enhance capacity building which if not paid attention to would lead to further deterioration of the current situation.
- Proper documentation of pre and post code events has a positive impact on the management of clinical condition of a patient as it help in better communication between healthcare providers during treatment and also handover between nurses.

Major findings in the study were:

- **On improving the compliance to MEWS based code activation and proper documentation of pre and post code events in medical records, led to a decline in fatal outcomes like death or cardiac arrest.**
- **There was also a decline in the cases who were still admitted in the hospital during the study exhibiting the importance of early warning signs and RRTs in managing the condition to reduce unprecedented admission to ICUs for critical intervention.**
- **However, the level of knowledge among nurses regarding early warning signs was observed to be below adequate and hence requires an immediate response in terms of capacity building and knowledge enhancement.**

CHAPTER 5: DISCUSSION

Early Warning Signs system can prove to be a beneficial tool if it is executed efficiently and in a standardized manner. One of the important aspects of an effective implementation was observed to be the prompt identification of vital signs and a timely arrival of the Rapid Response Team at the site of announcement of the code. As the study suggests an increase in the compliance to code orange to 100 percent led to a decrease in the percentage of cases of death as final outcome. In a similar study it was suggested by Chirag Mathukia et al¹², that a timely identification of vital signs can lead to a decline in the progression of an event to code blue and subsequent death of the patient. It can similarly be observed in this study that a decline in death as a final outcome was seen over the months when MEWS score based code activation and compliance to arrival of RRT on time increased to a hundred percent.

Prediction of adverse events through early identification of deterioration has a major impact on decline in fatal outcomes. The study observed only one third of the outcome as death whereas majority of the patients were successfully managed and discharged on completion of treatment. Both MEWS and PEWS have been associated with better clinical management and reduced fatality in several similar studies for adults as well children and infants. This was also enhanced by a full compliance to arrival of the rapid response team within 15 minutes of code activation as per the hospital policy. In a study by Mohammed Fayyaz Rashid et al¹³, it was observed that timely arrival of Rapid Response Team (RRTs) lead to a decline in code blue activation by 2.44 percent and a decline in in-hospital mortality rate by 4.88 percent. Conversely, in another study by Armando D et al¹⁴, it was observed that implementation of Early warning Signs system had no effect on the number of cases of ICU admission or ultimate outcome as death. However, it can be attributed to poor practise and lack of skills among the deployed nurses.

Therefore, level of awareness and skill set among the nurses is also a major factor in an effective implementation of EWS. As it is the primary duty of the nurses to monitor the patients admitted in wards at a regular interval, it becomes all the more essential for them to be thorough with the current practises and protocol of an emergency response activation at their hospital. This study suggested an inadequacy in the level of skills and knowledge among the nurses regarding early identification signs and protocol for code orange activation. They should also be prompt in recording any deterioration in the clinical condition of a patient as an early identification can provide ample time to take measures of prevent not only the sufferings of a patient, but also saves

the patient as well as the already overburdened health care professionals from the hassles of an unplanned emergency admission to ICUs.

The amount of knowledge regarding the RRT and Early Warning Signs System emphasizes on the importance of frequent educational programmes to help the nurses to keep them up to date with the required knowledge. According to Mohmoud Al Kaladeh et al¹⁵, on implementation of an educational programme for the nurses, it was seen that the nurses in the interventional group showed significant improvement in identification of early warning signs. However, the control group appeared to remain same without any change. It was observed that the nurses at the study setting were not at par with the knowledge required to identify early warning signs and protocol for rapid response activation. This can be attributed to the number of deaths and ICU admissions during the study period. However, this cannot be singled out as the primary or only reason for the outcome, but it can surely be inferred that the nurses require appropriate training to update their knowledge. This will consequently add to the improvement of patients' condition and stay at the hospital.

An overburdened nurse is a common scenario at any healthcare organization due to the poor nurse to patient ratio in India. In a situation where one nurse looks after 5-6 patients at a time, it can become difficult and tedious to record vital signs frequently. This might also fatigue leading to chances of reduced ability to identify sign of deterioration at an early stage promptly. As per a study, recording a set of vital signs for one patient on an average takes around 3 minutes without any disturbance and the time doubles if there are interruptions in between¹⁶.

Implementation of digital technology can be of utmost importance in a situation like this. World is transitioning into an era of AI(Artificial Intelligence) and ML(Machine Learning), and this has proved to be a useful tool in improving healthcare delivery in many aspects. Wearable devices that record vital signs at regular intervals can help in easing off the hassles occurred on recording the signs physically. It is common practise to be seen in an ICU where patients are regularly monitored through machines. However, patients admitted in wards are left dependent only on nurses and attending doctors. Wearable devices can be an easy and cost effective solution to record patient vitals and help in better prediction of deterioration. These devices are available in the form of chest straps, arm bands, wrist bands, clothing based, etc¹⁷.

LIMITATIONS

- As the time period of this study was brief, the number of samples is small which might not give the correct picture of the results obtained.

- Some of the nurses in duty declined to participate in answering the questionnaire and hence the result cannot be generalized for all the nurses deployed in the hospital.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

This study concludes that Early Warning Scoring system is an effective tool to identify patients who are at risk of clinical deterioration and to prompt early identification. The objective wise conclusion of the study is as follows:

- **The percentage of cases of code announced as per MEWS Score more than 4 during code.**

It was seen that on improvement of the overall compliance of adherence to code activation based purely on MEWS score and proper documentation led to reduced fatalities and better management of patients. A code activation based on proper threshold score not only makes it easier for the rapid response team to reach the patients within due time but it also helps in optimisation of the resources as it can lead to prioritization of the patient and resource allocation to the patient who is in actual need of critical care.

Recommendation:

- Implementation of Regular training and educational programmes for not only nurses but other health care providers on various ways of identification of early signs of deterioration as well as the correct scoring method.

- **The compliance of percentage of cases of code announced with correct pre and post event documentation**

It was found that an improvement in the documentation process of the adverse event as well as code led to a decline in death as well as helped in better prognosis of patients. Documentation before an event is important as it helps in deciding the need for a code orange activation based on the condition and vital signs of the patients before an adverse event occurs. Similarly, post code documentation not only leads to better communication among team members but also helps in taking a correct course of action to decide the further line of treatment. It also serves as a record in case of death and any legal formalities.

Recommendations:

- There should be occasional audits to evaluate the performance of nurses and doctors concerning the adherence to the hospital protocol.

- **The compliance to Arrival of RRT on code activation time of the code orange team within 15 mins.**

As per the hospital protocol, it is determined that once a code orange is activated following an adverse event with a patient, the rapid response team should reach the site within 15 minutes. Time plays a crucial role in progression of a fatal event and every single minute is of importance to save a patient from falling into a code blue and subsequently a cardiac arrest. Hence, it was observed that on improvement in the number of code orange cases where the RRT reached within 15 minutes, the final outcome improved as well leading to a decline in death as well in number of ICU admissions.

Recommendations:

- There should be occasional audits to evaluate the performance of nurses and doctors concerning the adherence to the hospital protocol.

- **The level of awareness about Early Warning Signs and code orange activation among nurses deployed in IPDs and Day care.**

It also evaluates the level of knowledge among the nurses as they are mostly the first point of contact a patient has while being admitted in a ward and are majorly responsible in day to day care of the patients. Hence, it is extremely important for them to be thorough with the identification and recording of early signs. A lack of knowledge among them as suggested by this study should not be overlooked as it brings out the importance of the implementation of frequent trainings and workshops that any organization can provide in order to not only improve the efficiency of their workforce but also add to better healthcare delivery in a hospital.

Recommendations:

- Implementation of Regular training and educational programmes for not only nurses but other health care providers on various ways of identification of early signs of deterioration.
- There should be a module on hospital policy regarding code orange activation criteria during the induction period of new nursing staff.

- Introduction of digital devices that can be easily worn by patients in the form of rings, wrist bands, etc to monitor patient vital signs along with nurses for an effective management.

Overall, the use of early warning sign scoring systems is an important strategy for improving patient care and outcomes. By identifying patients who are at risk of deterioration and facilitating timely interventions, these systems can help to improve patient safety, standardize care, and prevent adverse events.

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ANNEXURES

Annexure 1: Modified Early Warning Score Sheet in adult patients

MEWS KEY 0 1 2 3 **Modified Early Warning Score (MEWS)**

TIME		8	10	12	14	16	18	20	22	24	2	4	6	Score
RESPIRATORY RATE (BREATHS/MINUTE)	≥ 25													3
	21 - 24													2
	12 - 20													0
	9 - 11													1
	≤ 8													3
SPO2 (%)	≥ 96													0
	94 - 95													1
	92 - 93													2
	≤ 91													3
	TEMP (F)	≥ 102												
99.1 - 101.9														1
97 - 99														0
95.1 - 96.9														1
≤ 95														3
BLOOD PRESSURE (MMHG)	≥ 220													3
	201 - 219													2
	181 - 200													1
	101 - 180													0
	81 - 100													1
	71 - 80													2
	≤ 70													3
HEART RATE (BEATS PER MINUTE)	≥ 140													3
	111 - 139													2
	101 - 110													1
	51 - 100													0
	41 - 50													1
	≤ 40													3
Supplimental O2	Yes													2
	No													0
Glasgow coma scale	15													Best Response
	13 - 14													Mild
	9 - 12													Moderate
	3 - 8													Severe
Total score														
Pain Score														
RBS														
Verified by TL/ Incharge (with ID No.)														

Annexure 2: Paediatric Early Warning Score Sheet in patients of age 0-12 months

PEWS KEY 0 1 2 3 **Pediatric Early warning Score (PEWS) (0 - 12 Months)**

TIME		8	10	12	14	16	18	20	22	24	2	4	6	Score
RESPIRATORY RATE (BREATHS/MINUTE)	≥ 80													3
	70 - 79													2
	60 - 69													1
	30 - 59													0
	20 - 29													1
	16 - 19													2
	≤ 15													3
SpO2 (%)	≥ 94													0
	90 - 93													1
	86 - 89													2
	≤ 85													3
TEMP (F)	≥ 102													2
	99.1 - 101.9													1
	97 - 99													0
	95.1 - 96.9													1
	≤ 95													3
BLOOD PRESSURE (MMHG)	> 160													3
	131 - 160													2
	111 - 130													1
	71 - 110													0
	61 - 70													1
	50 - 60													2
	< 50													3
HEART RATE (BEATS PER MINUTE)	> 220													3
	181 - 220													2
	161 - 180													1
	111 - 160													0
	91 - 110													1
	80 - 90													2
	< 80													3
Supplimental O2	Yes													2
	No													0
Glasgow coma scale	15													Best Response
	13 - 14													Mild
	9 - 12													Moderate
	3 - 8													Severe
Total score														
Pain Score														
RBS														
Verified by TL/ Incharge (with ID No.)														

Annexure 3: Paediatric Early Warning Score Sheet in patients of age 13 months - 8 Years

PEWS KEY 0 1 2 3 **Pediatric Early warning Score (PEWS) (13 MONTHS - 8 YRS)**

	TIME	8	10	12	14	16	18	20	22	24	2	4	6	Score
RESPIRATORY RATE (BREATHS/ MINUTE)	≥ 35													3
	26 - 34													2
	12 - 25													0
	9 - 11													1
	≤ 10													3
SP02 (%)	≥ 94													0
	90 - 93													1
	86 - 89													2
	≤ 85													3
TEMP (F)	≥ 102													2
	99.1 - 101.9													1
	97 - 99													0
	95.1 - 96.9													1
	≤ 95													3
BLOOD PRESSURE (MMHG)	≥ 220													3
	201 - 219													2
	181 - 200													1
	101 - 180													0
	81 - 100													1
	71 - 80													2
	≤ 70													3
HEART RATE (BEATS PER MINUTE)	≥ 160													3
	140 - 159													2
	110 - 139													1
	70 - 109													0
	60 - 69													1
	< 60													3
Supplimental O2	Yes													2
	No													0
Glasgow coma scale	15													Best Response
	13 - 14													Mild
	9 - 12													Moderate
	3 - 8													Severe
Total score														
Pain Score														
RBS														
Verified by TL/ Incharge (with ID No.)														

Annexure 4: Paediatric Early Warning Score Sheet in patients of age above 8 years

PEWS KEY 0 1 2 3 **Pediatric Early warning Score (PEWS) (Above 8 YRS)**

	TIME	8	10	12	14	16	18	20	22	24	2	4	6	Score
RESPIRATORY RATE (BREATHS/MINUTE)	≥ 40													3
	30 - 39													2
	16 - 29													0
	11 - 15													1
	≤ 15													3
SP02 (%)	≥ 94													0
	90 - 93													1
	86 - 89													2
	≤ 85													3
TEMP (F)	≥ 102													2
	99.1 - 101.9													1
	97 - 99													0
	95.1 - 96.9													1
	≤ 95													3
BLOOD PRESSURE (MMHG)	≥ 220													3
	201 - 219													2
	181 - 200													1
	161 - 180													0
	81 - 100													1
	71 - 80													2
	≤ 70													3
HEART RATE (BEATS PER MINUTE)	≥ 180													3
	170 - 179													2
	150 - 169													1
	100 - 149													0
	70 - 99													1
	60 - 69													2
	< 60													3
Supplimental O2	Yes													2
	No													0
Glasgow coma scale	15													Best Response
	13 - 14													Mild
	9 - 12													Moderate
	3 - 8													Severe
Total score														
Pain Score														
RBS														
Verified by TL/ Incharge (with ID No.)														

Annexure 5: Questionnaire on Early warning Signs and Code Orange

Questionnaire for Code Orange

Please tick (✓) for correct option.

1. What is the reason to activate code Orange?
 - a) To reduce the chances of fire
 - b) In case of child abduction
 - c) To identifying early warning signs in patients and prevent further deterioration
 - d) In case of cardiac arrest
2. What is the number to be dialed to activate code Orange?
 - a) 2222
 - b) 1111
 - c) 1212
 - d) 2121
3. Code Orange can be activated from which areas in the hospital?
 - a) IPD
 - b) ICU
 - c) IPD/Day Care
 - d) anywhere in the hospital
4. What is the criteria for code orange activation in Medanta?
 - a) Patient MEWS Score
 - b) Patient ordered for ICU shifting
 - c) Patient with bleeding from surgical site
 - d) Patient experiencing severe pain
5. What should be the minimum score to activate code Orange?
 - a) 0-1
 - b) 2-4
 - c) 5-6
 - d) 7 or above
6. Can MEWS Score be used for paediatric patients?
 - a) Yes
 - b) NoIf no, write the name of the scale used for paediatric _____
7. What is the response time of RRT after a code has been announced?
 - a) Immediately
 - b) within 5 minutes
 - c) within 15 minutes
 - d) one hour
8. Can code Orange be activated if there is a fall in score as per Glasgow coma scale?
 - a) Yes
 - b) No
9. Where do you document the code orange note in patient medical record?
 - a) Nursing notes
 - b) E-HIS
 - c) Handover notes
 - d) EMR
10. If the code orange team has not arrived , and the patient's condition keeps deteriorating what is the next action to be done-
 - a) Shift the patient to ICU
 - b) Announce code blue
 - c) Wait for Team to Arrive
 - d) Inform treating physician

Annexure 6: Tabulation of reviewed literature

S.No	Title	Author (years)	Study location	Sample size	Sampling technique	Salient features
1.	The Role of Modified Early Warning Score (MEWS) in the Prognosis of Acute Pancreatitis	Amena Khan, Digvijoy Sarma, Chiranth Gowda, and Gabriel Rodrigues (2021)	Department of General Surgery at Kasturba Medical College University Hospital, Manipal, India	200	-	Out of 200 cases, 120 had mild AP, 65 had relatively moderate SAP and localized complications while 15 cases presented with severe AP along with organ failure. MEWS was principally set up to be a dependable index for early identification of patients and prevent development of progression

						of SAP. It was found out that a MEWS >2 on the day of onset is most accurate in prognosticating chances of severe AP, with a specificity of 90.8% and PPV of 83.3%. While mean of total MEWS > 1.2 on day two was accurate in predicting SAP with 81.3% sensitivity and PPV of 69.8%.
2.	Identification of deteriorating patients on general wards; measurement of vital parameters and potential	Jeroen Ludikhuize MD, Susanne M. Smorenburg MD, PhD, Sophia E. de Rooij MD, PhD, Evert de Jonge	Academic Medical Centre in Amsterdam, the Netherlands	204	-	This study was aimed to study the current practise of nurses regarding the measurement of vital signs

	effectiveness of the Modified Early Warning Score	MD, PhD (2012)				and utility of MEWS in early recognition of patients who subsequently passed away or endured severe AEs. An aggregate of 2688 measures of one or further vital signs were taken in 48 hours before a severe adverse event including cardiopulmonary arrest, unplanned ICU admission, etc for all 204 cases. Around 81% of the cases had a MEWS score of over 3 at least once prior to
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						progression into an AE.
3.	Recognizing Early Warning Signs (EWS) in Patients Is Critically Important	Shamsa Samani, Salma Amin Rattani (2023)	School of Nursing and Midwifery, Aga Khan University, Karachi, Pakistan.	33	-	This study was conducted to assess the factors that promote or impede the detection of early warning signs among adult patients rehabilitated in tertiary care hospitals. A literature review was executed in various databases; identified records, the Cumulative Index to Nursing and Allied Health Literature (CINHAL), Google Scholar, PubMed, Science

						Direct, and Sage. The literature review found out that long hours of shift, nurse staffing levels, missed vital signs, lack of nursing training and education, and communication impacted nurses' ability to identify and retort to early warning signs.
4.	Monitoring Vital Signs: Development of a Modified Early Warning Scoring (Mews) System for General Wards in a Developing	Una Kyriacos ,Jennifer Jelsma,Michael James,Sue Jordan (2014)	Government Hospital, Cape Town	12	Purposive Sampling	The aim of the study was to develop and validate, by agreement, the construct and content of an compliance map for

	Country					nurses incorporating a modified early warning scoring (MEWS) system for physiological parameters to be used for bedside monitoring on general wards Around $\geq 70\%$ consensus was reached for cut points in five of seven physiological parameters respiratory and heart rates, systolic BP, temperature, and urine output. The final consensus deduced Cape Town
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						ward MEWS compliances chart incorporated seven physiological parameters with their respective colour-banded cut points (thresholds) and weighted detector points (0=normal, upper, and lower 1 to 3).
5.	Evaluation of rapid response team implementation in medical emergencies: A gallant evidence based medicine initiative in developing countries for serious adverse events	Mohammed Fayyaz Rashid, Mohammed Imran, Yash Javeri, Monika Rajani, Shadab Samad, and Omender Singh (2014)	Max, Super Specialty Hospital, Saket, New Delhi, India	51	-	This study was undertaken to estimate the impact of RRT perpetration on patients' final during medical emergencies. Outcomes such as patient stayed in the room,

						patient transfer to intensive care unit (ICU), patient discharge and generation of code blue event, mortality, and length of stay in hospital/ICU were measured. Analysis of 41 RRT calls showed decreased code blue calls by 2.44% and decrease in mortality by 4.88%
6.	Do paediatric early warning systems reduce mortality and critical deterioration events among children? A systematic	Shu-Ling Chong, Mark Sen Liang Goh, Gene Yong-Kwang Ong, Jason Acworth, Rehena Sultana, Sarah Hui Wen Yao, Kee Chong		15	-	A systematic review and meta-analysis were done to assess if Paediatric Early Warning System in a

	review and meta-analysis	Ng (2022)				hospital setting was effective to reduce clinical deterioration ,Severe adverse events or mortality as compared to usual care without PEWS.
7.	Role of Emergency Response Codes in Handling Hospital Emergencies – An Experience of Protocol, Designing, Development, and Implementation in a Large Multispecialty Tertiary Care Teaching Hospital,	Sathish Raju Nilakantam ¹ , M D Ravi, Jayati Bahuguna, M Dayananda ⁴ (2020)	JSS Medical College, Mysuru, India	-	-	The objectives of the study were to prepare standard operating procedures (SOPs) using codes for various emergency situations that arise and to implement the same in the hospital.

	Mysuru, India					
8.	Scoping Review of Paediatric Early Warning Systems (PEWS) in Resource-Limited and Humanitarian Settings	Stephanie R. Brown, Daniel Martinez Garcia, and Asya Agulnik (2019)		72		This study was aimed to review the available literature on use of PEWS to prevent adverse events among paediatric patients in resource limited and public health setting. PEWS was identified to accurately predict children with higher severity of illness
9.	Early warning scoring system for early recognition of and timely intervention in deteriorating patients in the hospital	Ravikirti (2014)	AIIMS Patna, Bihar	-	-	It was an article on various types of Early Warning Systems used worldwide and its implication

						in Indian context. It was seen that the system was inefficiently utilized in various tertiary hospitals. The main reason identified was lack of standardization of activation criteria.
10.	Minimal Impact of Implemented Early Warning Score and Best Practice Alert for Patient Deterioration	Armando D. Bedoya, MD MMC, Meredith E. Clement, MD, Matthew Phelan, MS, Rebecca C. Steorts, MS PhD ,Cara O'Brien, MD, and Benjamin A. Goldstein, PhD (2020)	Duke University, Durham, North Carolina	85322		This study was undertaken to determine the effectiveness of National Early warning Score system implementation on prevention and prediction of any

						deterioration in clinical condition of patients. It was identified that primary outcome of death or potential admission to ICU had no change even on implementation of NEWS. However, this was attributed to poor practise and lack of required skills in nursing staff.
11.	The Value of Modified Early Warning Score (MEWS) in Surgical In-Patients: A Prospective Observational Study	J Gardner-Thorpe, ¹ N Love, J Wrightson, S Walsh, and N Keeling	West Suffolk Hospital, Bury St Edmunds, UK	334		The primary objective of the study was to assess the level of MEWS score to activate a call-out trigger

						It was observed that for all the trigger callouts, Mthe EWS score was four or more and ICU patients has more triggers as compared to elective patients. It was also observed in the majority of the cases that an early trigger resulting into patient management successfully in wards and reduced the chances of unplanned ICU admission.
12.	Modified Early Warning System improves	Chirag Mathukia WuQiang	Easton Hospital, PA, USA	726		This study was conducted to assess the

	patient safety and clinical outcomes in an academic community hospital	Fan, Karen Vadyak, Christine Biege, and Mahesh Krishnamurthy (2015)				impact of implementation of MEWS on improvement of patients' clinical condition in a hospital. The number of RRTs increased from 0.24 percent to 0.48 percent. A decline was observed in progression of code blue and inpatient mortality rate from 2.3 percent to 1.2 percent.
13.	Effectiveness of Education on Modified Early Warning System for Nurses	Janakaraj, Shanmugavalli (2020)	Walden University	26		The study was undertaken to evaluate the delay in identification of clinical deterioration

						of patients by nurses due to their lack of knowledge about early warning signs. It also identified an inadequacy of knowledge among staff. The effectiveness of education was seen through an increase in the level of nurses' awareness by over 90 percent.
14.	Early warning score challenges and opportunities in the care of deteriorating patients	John Asger Petersen (2018)	Bispebjerg Hospital, an inner-city Hospital in Copenhagen, Denmark	144		This study was aimed to assess the various aspects of Early warning scoring system in Public

						Hospitals. The documentation process and adherence to protocol was determined in the study. It was found that poor adherence to protocol in frequency of monitoring and aptness of clinical response was seen before any severe adverse event.
15.	The impact of the use of the Early Warning Score (EWS) on patient outcomes: a systematic review	N Alam , E L Hobbelink , A J van Tienhoven , P M van de Ven , E P Jansma , P W B Nanayakkara (2014)	VU University, Netherlands	7		It was a systematic review aimed to assess the impact of EWS on patient outcomes like, length of stay, pattern of ICU

					admission. Cardiac arrests, etc A mixed observation was seen, where a few articles suggested decline in severe outcomes based on Early Warning Signs. However, some articles identified no difference in in hospital mortality. It was concluded that Early Warning System was a simple bedside scoring tool which could potentially help in reducing
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						severe adverse events and improve clinical outcomes.
16.	A Protocolised Once a Day Modified Early Warning Score (MEWS) Measurement Is an Appropriate Screening Tool for Major Adverse Events in a General Hospital Population	Louise S van Galen , Casper C Dijkstra , Jeroen Ludikhuize , Mark H H Kramer , Prabath W B Nanayakkara (2016)	VU University Medical Centre Amsterdam	1053	Simple random sampling	This study was aimed to analyse protocol adherence to MEWS protocol and determine the predictive value of protocolised daily MEWS measurement on severe adverse events The MEWS of 3 or higher was a strong predictor of clinical endpoints such as in-hospital mortality, 30-day

						readmissions, hospital length of stay Patients with critical scores had significant higher rates of unplanned ICU admissions [7.0% vs 1.3%, $p < 0.001$], in-hospital mortality [6.0% vs 0.8%, $p < 0.001$], 30-day readmission rates [18.6% vs 10.8%, $p < 0.05$], and a longer length of stay [15.65 (SD: 15.7 days) vs 6.09 (SD: 6.9), $p < 0.001$]
17.	Why do healthcare professionals fail to escalate	S M O'Neill , B Clyne , M Bell , A Casey , B	The Health Information and Quality Authority,	18	Convenience sampling	The study was conducted to assess the

	as per the early warning system (EWS) protocol? A qualitative evidence synthesis of the barriers and facilitators of escalation	Leen , S M Smith , M Ryan , M O'Neill (2021)	Ireland			potential cause of failure of health care professionals to identify early warning signs, identify the barriers and facilitators of escalation process. Five thematic schemes were developed to categorise the barriers and facilitators: Governance, Professional boundaries, RRT, Clinical experience and EWS vital parameters. Barriers included: Lack of Standardisation, Resources,
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						Lack of accountability, RRT behaviours, Fear, Hierarchy, Increased Conflict, Over confidence, Lack of confidence, and Patient variability. Facilitators were identified as: Accountability, Standardisation, Resources, RRT behaviours, Expertise, Additional support, License to escalate, Bridge across boundaries, Clinical confidence, empowerment
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						t, Clinical judgment.
18.	The impact of introducing the Modified Early Warning Score 'MEWS' on emergency nurses' perceived role and self-efficacy: A quasi-experimental study	Mahmoud Al-Kalaldeh , Khaleel Suleiman , Loai Abu-Shahroor , Hala Al-Mawajdah (2019)	Al-Zaytoonah University of Jordan, Jordan	232	Clustered Sampling	It was conducted to assess the impact on self-efficacy of nurses in emergency by introduction of an educational programme on MEWS. The sample was divided into two groups: Interventional (n=118) and Control group (n=114). The interventional group showed a significant change in efficiency and awareness

						about their perceived roles after the intervention, whereas the control group showed no change.
19.	How long do nursing staff take to measure and record patients' vital signs observations in hospital? A time-and-motion study	Chiara Dall'Ora , Peter Griffiths , Joanna Hope , Jim Briggs , Jones Jeremy , Stephen Gerry , Oliver C Redfern (2021)	School of Health Sciences, University of Southampton, Highfield Campus, Southampton, United Kingdom	4 hospitals		This study was undertaken with an objective to determine the time taken to measure the vital signs of patients and the factors involved in the time required to record the vital signs. The estimated time without any interruption for bedside monitoring was recorded as 3 minutes

						45 seconds and with interruptions as 6 minutes 26 seconds. No substantial difference was found in time across the four hospitals even though different parameters and systems were used to record the vital signs.
20.	Wearable devices for remote vital signs monitoring in the outpatient setting: an overview of the field	Stephanie Soon, Hafdis Svavardottir, Candice Downey, David George Jayne (2020)	Leeds Institute of Medical Research, UK	270		This was a scoping study of literature on the usage of wearable devices to comprehensively monitor vital signs of patients. A total of 30 wearable monitors were

						identified that included, 6 patches, 3 clothing-based monitors, 4 chest straps, 2 upper arm bands and 15 wristbands. Heart rate monitoring was most commonly done using devices whereas BP and O2 saturation were the least to be measured.
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Annexure 7: Additional warning signs specific to disease conditions

In Wards:

- Surgical site: Any abnormal oozing, bleeding from the site, or colour change (either pale or purple colour).
- Tracheostomy: If there is no air blast (pressure or air movement can be felt with the dorsum of hand every 2 hours for 10 seconds if no air movement or pressure; then the tracheostomy tube is blocked or dislocated).
- Stoma output for gastro patients: >1000 ml/day or if there is a change in the colour of the drain from the previous colour of the drain
- Abdominal girth in a patient of ascites: If the current reading is > 2cm than the previous reading.
- Skin flap monitoring: If the colour is pink/red, it is normal; Brown/black colour indicates abnormal flap (flap rejection)
- Weight (Applicable to liver and kidney transplant units): If change in weight as compared to the previous reading (on re-checking) before shifting to Operation Theatre (OT).
- Skipped or overdose of any high risk medications.
- High-grade fever (Temperature more than 38.3 degrees C (101 degrees F) in case patient was afebrile before or more than 40 degrees C (104 degrees F) if he already had a fever) / sudden episode the of patient becoming cold or clammy.
- Severe pain not relieved by pain killer (if pain score is more than 4 after ½ hour of IV/IM injection or pain score more than 4 after 2 hours of oral medication).
- Upper or lower Gastrointestinal bleed and Malena.
- Frank bleeding per vaginum (1 vulval pad - fully soaked) in gynaecology – post-operative patients

In ICUs:

- ABG Values: PO₂<70; PCO₂>50; pH<7.30/>7.50
- Blood Sugar: RBS<60 mg/dl
- Vital signs: Blood pressure <80 mm Hg systolic; Temperature: >38 degree C or <36 degree C; Heart rate: <40/>120 beats /min SpO₂: <90% on O₂
- Urine output: <50ml over 4 hours
- ECG variations

- Drain output: >200ml/hour
- CVP : <5/>12 cm of water
- **For Neurology patients:**
 - Fall in GCS (esp. sensorium and motor response)
 - Any changes in power grading of limbs
 - Lumbar drain: >150ml over 24hrs
 - External Ventricular Drain : >150 ml over 24hrs
 - If the patient develops sudden slurred speech, drooping face, weakness of limbs, decreased sensation, diplopia/ blurred vision, tremors/twitches/increased tone, difficulty in swallowing, unstable walking
 - Headache/ Backache : Pain score above 4/10 on Wong baker and FLACC, 5/12 on BPS
 - Any suspicious Cerebrospinal fluid (CSF) leaks through the nose/ear.
- **For renal transplant patients:**
 - Urine output: <300ml/hr.
- **Liver transplant patients:**
 - Drain output: More than 100ml/hr or change in colour of the drain, leak, blood in drain and soakage on site.
 - Heart rate : >110/min
 - Urine output <50 ml/hr over 4 hrs.
- **Cardiac/Cardiothoracic Vascular Surgery patients:**
 - Elevated cardiac enzymes like CPK, CPKMB, TROP-I
 - Cardiac Index: <2.0 l/min/square meter
- **Post-operative recovery:**
 - Enlarging hematoma at the surgical site
 - Excessive drainage (>4 ml/kg/hr)