Project Title

Automated Code Red Alerts (ACRA) and ICU Outreach Nursing (ICUORN) Service

Project Lead and Members

Project members: Low TJ, Rebecca Lim, Patricia Leong, Ong YM, Kelvin Lew, Jeremy Tan, Faheem Khan

Organisation(s) Involved

Ng Teng Fong General Hospital (NTFGH)

Healthcare Family Group(s) Involved in this Project

Nursing

Applicable Specialty or Discipline

Intensive Medicine

Project Period

Start date: 2020 (Pilot phase)

Completed date: 2023

Aims

The first-of-its-kind in local public healthcare institutions (PHIs), Automated Code Red Alert (ACRA) system was piloted in Ng Teng Fong General Hospital (NTFGH) in 2020. This automated alert system, along with ICU Outreach nursing (ICUORN) service, improves care escalation by automating the identification of clinically deteriorating patients while in GW, and triggers notification to the appropriate clinicians, thus reducing cardiac arrests in GW and unplanned ICU admissions. The combination of ACRA triggering system and ICUORN service aims to improve compliance rate to timely and appropriate care escalation and facilitate efficient intervention during clinical deterioration in the GW.

1. To improve compliance rate to timely and appropriate care escalation.

2. To facilitate efficient intervention during clinical deterioration in the General Wards (GW).

3. To reduce cardiac arrests and unplanned ICU admissions in the General Wards.

Background

Patients in General Wards are at risk of deterioration due to marked changes in their vital signs. Compliance to care escalation by nurses was between 0-15%, leading to serious outcomes such as unplanned ICU admissions, respiratory or cardiac arrest, and death. The Automated Code Red Alert (ACRA) system, along with ICU Outreach Nursing (ICUORN) service, was piloted in NTFGH in 2020 to improve care escalation by automating the identification of clinically deteriorating patients and triggering notifications to appropriate clinicians.

Methods

1. Two-pronged approach: ACRA automated triggering and upskilling of ICU nurses to ICUORNs.

2. General Ward nurses assessed six physiological parameters: respiration rate, oxygen saturation, systolic blood pressure, pulse rate, level of consciousness, and temperature.

3. Data fed into ACRA system, with monitoring frequency based on patient severity using the National Early Warning Score 2 (NEWS2) and hospital policy.

4. Automated notifications triggered to ICUORNs and senior clinicians for prompt care escalation.

5. Proof-of-Concept (POC) testing phase followed by gradual implementation across all inpatient wards.

6. Integration with other projects like TELE-NIV and VitaScout for continuous monitoring of critically ill patients.

Results

1. 100% compliance rate in escalating care to the right clinicians.

2. Reduction in incidence of In-Hospital Cardiac Arrest (IHCA) from 1.42-1.46 (2020-2021) to 1.17 (2023).

3. Reduced ICU/HD admissions through early intervention to only 8% of alerted patients.

4. Seamless transfer to ICU/HD through ICUORN for closer monitoring and early intervention.

5. Efficiency and resource optimization with ICUORN, preventing patient deterioration and enhancing access to critical care resources.

Lesson Learnt

A key lesson learnt was that GW patients can be effectively managed by clinicians with ICUORN support using smart technology. The implementation of the ACRA system with the ICUORN service ensured efficient timely intervention during clinical deterioration, facilitating timely identification of at-risk patients in the GW. Digitising processes and leveraging of existing infrastructure, including the NEWS2 score, has improved compliance to escalation policies, resulting in reduced unplanned ICU admissions, shorter hospital stays, and decreased costs.

Additional Information

National Healthcare Innovation & Productivity (NHIP) 2024 – Best Practice (Automation, IT and Robotics category)

Conclusion

The implementation of the ACRA system with ICUORN service has ensured efficient and timely intervention during clinical deterioration, significantly improving patient safety and care quality. The approach has led to reduced unplanned ICU admissions, shorter hospital stays, and decreased costs.

Project Category

Technology

Digital Health, Sensors, Data Analytics

Workforce Transformation

Job Redesign, Upskilling

Keywords

Automated Code Red Alert, ICU Outreach Nursing, Clinical Deterioration, Early Intervention, Patient Safety, Critical Care

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Automated Code Red Alerts (ACRA) and ICU Outreach Nursing (ICUORN) Service

MEMBERS: Low TJ, Rebecca Lim, Patricia Leong, Ong YM, Kelvin Lew, Jeremy Tan, Faheem Khan

Intensive Care / High Dependency Unit, Ng Teng Fong General Hospital

Define Problem, Set Aim

Problem / Opportunity for Improvement

Patients in General Wards (GW) are at risk of deterioration due to marked changes in their vital signs. Compliance to care escalation to the appropriate clinicians by nurses ranged between 0-15%. Delays in care escalation and inadequate responses from clinicians can lead to serious outcomes, including unplanned Intensive Care Unit (ICU) admissions, respiratory or cardiac arrest, and death.

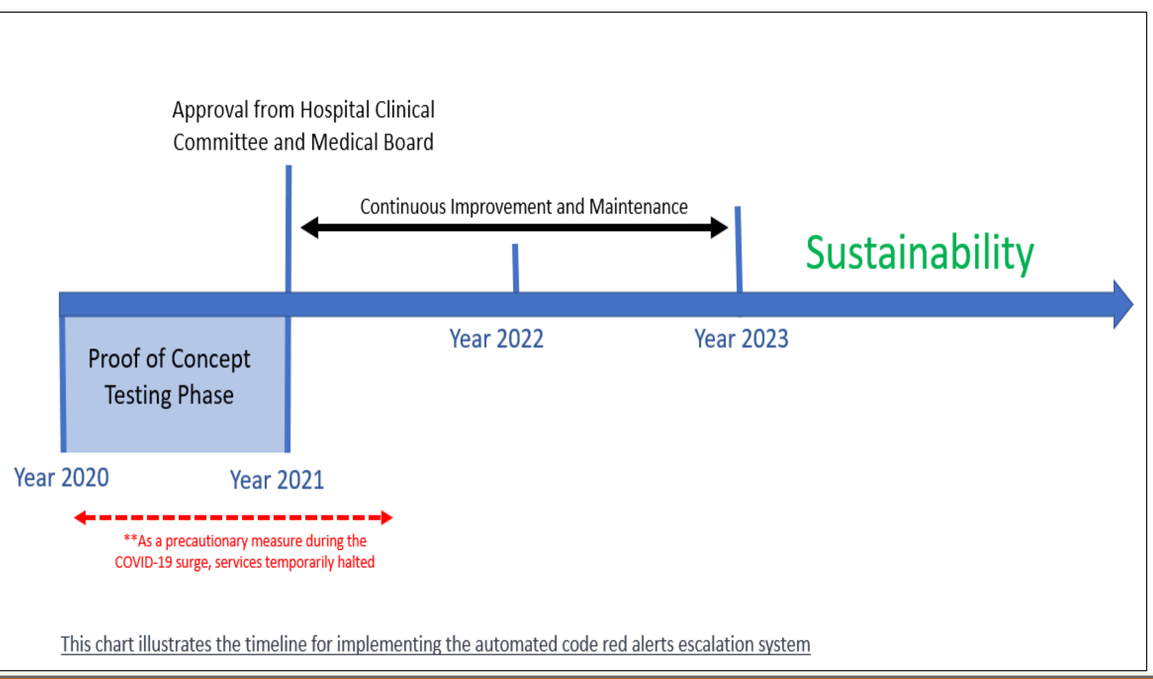
Aim

The first-of-its-kind in local public healthcare institutions (PHIs), Automated Code Red Alert (ACRA) system was piloted in Ng Teng Fong General Hospital (NTFGH) in 2020. This automated alert system, along with ICU Outreach nursing (ICUORN) service, improves care escalation by automating the identification of clinically deteriorating patients while in GW, and triggers notification to the appropriate clinicians, thus reducing cardiac arrests in GW and unplanned ICU admissions. The combination of ACRA triggering system and ICUORN service aims to improve compliance rate to timely and appropriate care escalation and facilitate efficient intervention during clinical deterioration in the GW.

Establish Measures

Measurements Defined:

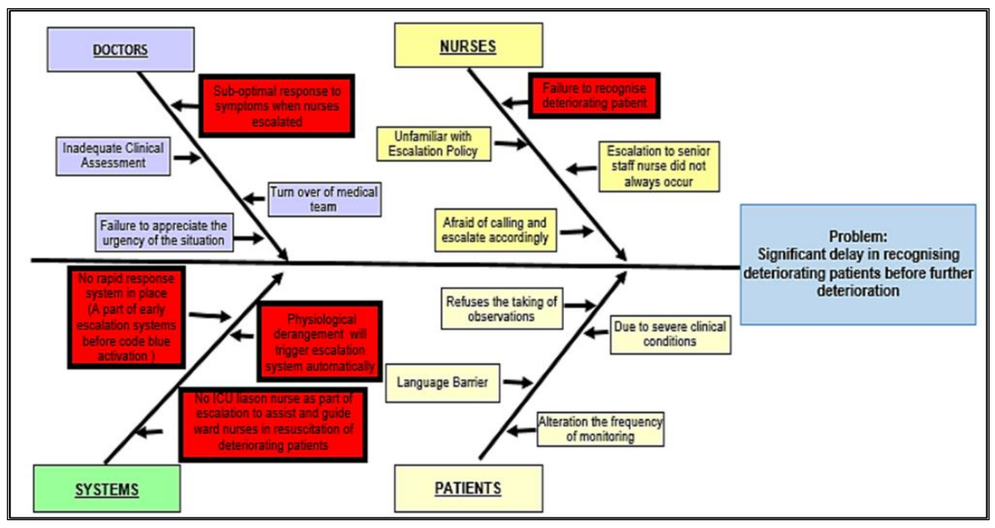
1. Compliance Rate in Escalating Care to the Right Clinicians
2. Reduction in Incidence of In-Hospital Cardiac Arrest (IHCA)
3. Reduced ICU/HD Admissions Through Early Intervention
4. Seamless transfer to ICU/HD through ICUORN
5. Efficiency and Resource Optimization with ICUORN



This chart illustrates the timeline for implementing the automated code red alerts escalation system

Analyse Problem

There was no system in place to detect and recognise early deterioration in patients. Detection was predominantly reliant on the routine vital signs check by GW nurses. Hence, early deterioration signs were inadvertently overlooked, causing unnecessary delays in intervention and care escalation. This in turn, caused further unwarranted deterioration in patients' conditions. To assess the cause and extent of the problem, we illustrated the findings through a fishbone analysis:



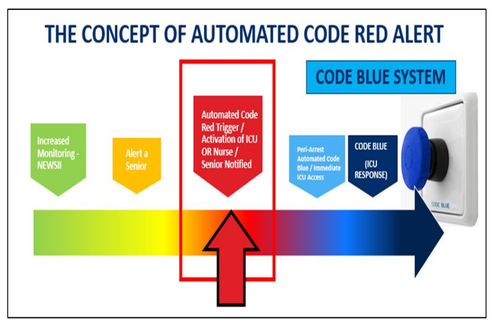
The following contributing factors were identified:

1. Inadequate response when nurses escalate signs of deterioration.
2. Failure by inexperienced nurses to recognise deteriorating vital signs.
3. Absence of a rapid response system before Code Blue activation is warranted.
4. Lack of automated triggers to patients' vital abnormalities.
5. Insufficient ICU nurse support in the reliable management of deterioration

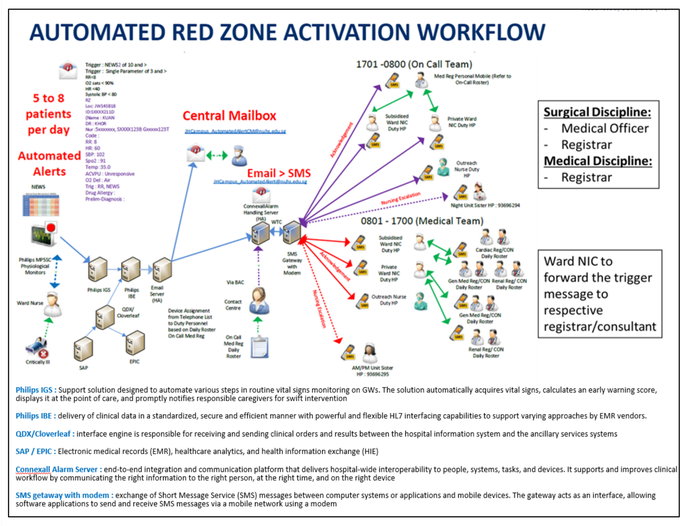
Select Changes

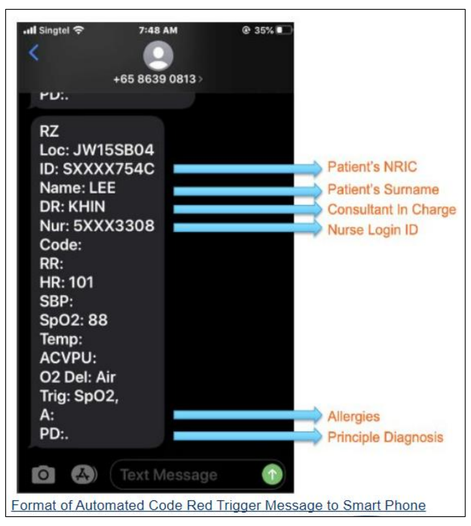
Referencing the Rapid Response System's (RRS) four components , which is a well-accepted standard of care, reactive approach to enhancing the recognition and management of clinical deterioration in hospitalised patients (Chalwin et al., 2018), provided the context for NTFGH's own model of care in the management of clinical deterioration.

RRS Components	Description	NTFGH's Model
Afferent Limb	The systematic process of monitoring and detecting deterioration supported by predefined criteria.	The existing code blue system and established policies, such as the Clinical Responses to NEWS2 trigger threshold (CRNTT), which provide guidance to nurses during vital sign deterioration.
Efferent Limb	The response team with expertise in managing deteriorating patients	ICUORN plays a crucial role, utilising ACRA triggering technology to promptly address deteriorating patients outside the ICU. Additionally, it assists in collecting data to enhance overall patient care and outcomes.
Patient Safety and Quality Improvement Limb	Oversees the overall management, coordination, and evaluation of the RRS	
Administrative or Governance Limb	Data Collection, Reporting, Feedback, and System Improvement	



Two-pronged approach – (1) ACRA automated triggering and (2) Upskilling of ICU nurses to ICUORNs. GW nurses assessed six physiological parameters: respiration rate, oxygen saturation, systolic blood pressure, pulse rate, level of consciousness, and temperature, and the data is fed to ACRA. Monitoring frequency escalated based on patient severity, and based on pre-set thresholds, in accordance with the National Early Warning Score 2 (NEWS2) and hospital policy, once within Red zone criteria, automated notifications are promptly triggered to ICUORNs and senior clinicians for prompt care escalation. This approach ensured accurate severity measurement and effective patient triage.





Format of Automated Code Red Trigger Message to Smart Phone

Results

1. **100% Compliance Rate in Escalating Care to the Right Clinicians**
   - Ensuring timely and appropriate escalation of care to the relevant clinicians.
2. **Reduction in Incidence of In-Hospital Cardiac Arrest (IHCA)**
   - IHCA rates decreased from 1.42-1.46 (2020-2021) to 1.17 (2023), indicating improved patient safety and care.
3. **Reduced ICU/HD Admissions Through Early Intervention**
   - Early intervention lowers ICU/HD admissions to only 8% of alerted patients, reducing the demand for higher-level care.
4. **Seamless transfer to ICU/HD through ICUORN**
   - Timely HD/ ICU admission for closer monitoring and early intervention prevents complications like organ failure due to prolonged hypoperfusion, which can lead to death
5. **Efficiency and Resource Optimization with ICUORN**
   - ICUORN prevents patient deterioration, manages efficiently, and enhances access to critical care resources.

A study by Chua et al. (2022) examined the impact of automated RRS activation on nurses' attitudes and responses to clinical deterioration. Results showed that over 80% of participants agreed that ICUORNs helped prevent deteriorating patients from progressing to cardiac arrests, efficiently managing deterioration, and facilitating access to critical care resources.

Spread Changes, Learning Points

After positive outcomes in the Proof-of-Concept (POC) testing phase and incorporating feedback, the solution was gradually implemented across all inpatient wards in NTFGH. ACRA notification and activation system, together with 24/7 ICUORN service, with established guidelines and work processes, was officially launched in 2022. At the same time, the solution was spread to other projects such as TELE-NIV - monitoring of patients with Non-invasive Ventilation (NIV)) and VitaScout - Continuous monitoring of vitals of critically ill patients in GW.

A key lesson learnt was that GW patients can be effectively managed by clinicians with ICUORN support using smart technology. The implementation of the ACRA system with the ICUORN service ensured efficient timely intervention during clinical deterioration, facilitating timely identification of at-risk patients in the GW. Digitising processes and leveraging of existing infrastructure, including the NEWS2 score, has improved compliance to escalation policies, resulting in reduced unplanned ICU admissions, shorter hospital stays, and decreased costs.

ACKNOWLEDGEMENTS :

1.)Ng Sow Chun, Chief Nurse
2.)Lye Siew Lin, Deputy Director Of Nursing
3.)Clarice Wee Li-Phing, Assistant Director Of Nursing
4.)Agnes Chong Yu Hooi, NC/APN
5.)Lim Xin Ling, ANC/APN
6.)Noormazreen Bin Maswan, Nurse Educator
7.)Liew Mei Pheng, Medical Informatics Specialist
8.)Lim Chong Gee, Engineer
9.)Yueh Ling Ling, Assistant Manager, ICM

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