An Analysis of the Critical Care Response Team Calling Algorithm: Integrating a Mobile Application into the Hospital IT Infrastructure

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Background

This study is a continuation of the work of Melanie Yeung[1] and Archana Gopal[2], the latter forms the basis of results informing on this project's current iteration.

Future evaluation will consist of the design and activation of a clinical decision support system, informing the CCRT staff once a vital signs collection has tripped the alarm criteria.

Four criteria were evaluated as part of this project:

1. The Ministry criteria modified for Mount Sinai Hospital's CCRT team (ACCESS)[3,7]
2. The Modified Early Warning Score[4] (MEWS)
3. The Cuthbertson Discriminant Functions[5] (CDF) alarm criteria
4. The VitalPAC™ Early Warning Score[6] (ViEWS)

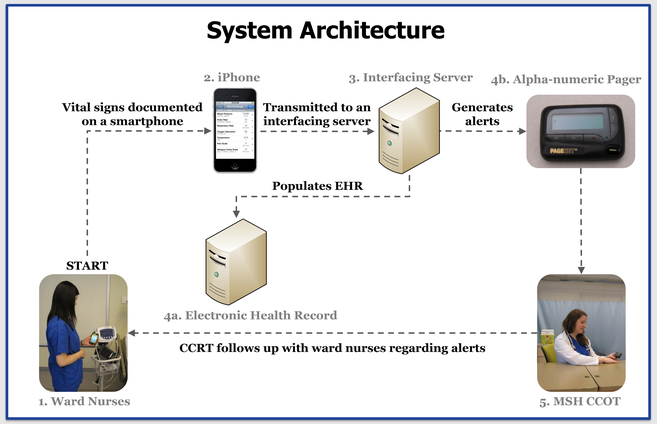
Research Questions

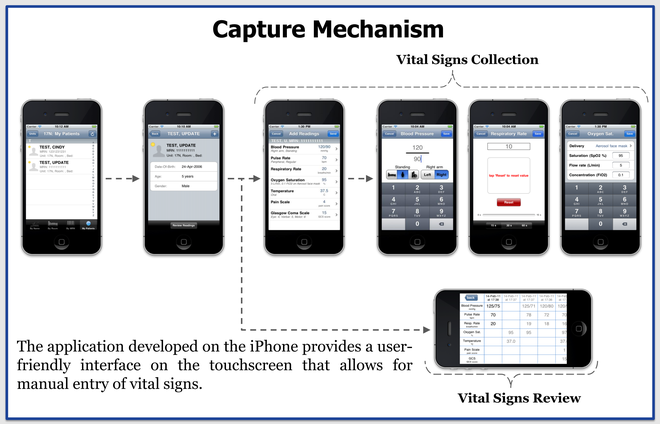
1. Which calling criteria defined in literature exhibits the greatest clinical effectiveness and how do alerts contribute to clinician practice?

2. In the design and usability testing of a clinical decision support system intended for the critical care environment, which components of said system are crucial to information processing?

3. Will context awareness allow for greater clinical utility within the context of a paper based environment and workflow?

Methodology





Following the collection of data, the alerting algorithms were applied to datasets passing through an interface server, allowing for the computation of alerts. These alerts were not sent through to the CCRT.

$$f1 = 0.030.HR + 0.085.RR - 0.003.sysBP - 0.430.Temp - 0.163.Sa_{O_2} + 27.583 \quad [1]$$

$$f2 = 0.027.HR + 0.091.RR - 0.155.Sa_{O_2} + 10.613 \quad [2]$$

$$f3 = 0.030.HR + 0.121.RR - 5.240 \quad [3]$$

Figure 1: CDF Alarm Criteria[5]

Alert Criteria	
Blood Pressure	≤ 90 or ≥ 200 or drop of > 40 mmHg
Consciousness*	Altered level of consciousness
Respiration Rate	≤ 8 or ≥ 30
Oxygen Saturation	< 90% on oxygen
Pulse Rate	≤ 40 or ≥ 130

*GCS was used to quantify consciousness. If GCS was not present in previous encounter, the previous value is assumed to be 15

Figure 2: ACCESS Alarm Criteria[3,7]

	3	2	1	0	1	2	3
Systolic Blood pressure (mmHg)	<70	71–80	81–100	101–199		⩾200	
Heart rate (bpm)		<40	41–50	51–100	101–110	111–129	⩾130
Respiratory rate (bpm)		<9		9–14	15–20	21–29	⩾30
Temperature (°C)		<35		35–38.4		⩾38.5	
AVPU score				**A**lert	Reacting to **V**oice	Reacting to **P**ain	**U**nresponsive

Figure 4: MEWS[4] Alarm Criteria

	ACCESS	CDF	MEWS	ViEWS
Number of alerts	96	36	24	68
Sensitivity	20.0	40.0	30.0	50.0
Specificity	92.1	97.6	98.6	95.0
PPV	2.2	12.5	15.8	8.2
NPV	99.2	99.5	99.4	99.5

Figure 5: Statistical Spread of Algorithm Calculations

Preliminary Results

Encounter data was collected from Mt. Sinai Hospital's internal medicine wards over a span of 2 months in 2011. An encounter was defined as the session in which all data parameters were collected. Sensitivity was defined as the ability for the algorithm to identify patients who are deteriorating, and specificity the opposite.

Based on an analysis of this encounter data shown in Figure 5, the ACCESS criteria exhibits a more limited ability to identify deteriorating patients when compared to other algorithms. Evaluating the clinical utility of each algorithm requires further investigation.

Future Work and Directions

Future work on this project intends to include:

- The activation of the alerts, providing clinical decision support to the CCRT through a dashboard interface at point of care for trend and pattern recognition of patient deterioration.
- Integration of the alerting algorithms into all vital signs documentation on the general internal medicine ward at Toronto General Hospital.
- The deployment of context aware Bluetooth low energy tags as a means to improve nursing workflow and adoption of mobile technology as a primary documentation tool.

References

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