Using a Rothman Index based Clinical Surveillance System to Reduce Mortality – a Randomized Controlled Trial

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Introduction
Early detection of subtle changes in a patient’s condition is critical to patient safety. A 5-day stay in the hospital has an average of 24 patient handoffs [1]. Through these high-risk events and during the course of the stay, subtle signs of early deterioration can easily be missed. Traditional vital sign-based early warning systems, which trigger during decompensation, have largely failed to impact outcomes [2,3]. The Rothman Index (RI) is a finely graduated, continuously updated, general measure of patient acuity based on empirically derived univariate relationships between 1-year post-discharge mortality and each of 26 clinical measurements and has been validated in many studies [4]. In addition to vital signs, it uses nursing assessments, which show the functional failures (loss of appetite, confusion, edema, difficulty walking…) which precede decompensation, during the “compensation” process. Implementation of surveillance protocols based on the RI have been shown to reduce unplanned transfers to ICU [5] and risk-adjusted mortality [6].

Methods
In a nurse-driven initiative at Houston Methodist Hospital (an 889-bed tertiary referral hospital), a surveillance system based on RI was implemented on 11 intervention clinical units. Historical controls (1/2014 – 9/2014) were used for the 11 clinical units as well as a concurrent control of 20 clinical units during the intervention period (10/2014 – 6/2015). A total of 33,797 patients were included in the controlled study, with additional post-study analysis conducted on data through 12/2016. The RI (by PeraHealth, Inc) was integrated into the hospital’s EMR and updated in real time (Fig. 1). Implementation was supported by a robust training agenda. On each unit, RI graphs, one for each patient, organized so that patients with poor or deteriorating scores were highlighted, were displayed. Monitors displaying the RI graphs for all patients on a unit were placed at nursing stations in each unit. Graphs were reviewed several times each day by nurses, e.g. at shift-change and during safety huddles. Nurse practitioners rounded on those patients whose RI graphs indicated high-risk. Protocols were established for bedside nurses, and charge nurses, specifying actions (e.g. increased monitoring, notification of physicians) to be taken when RI graphs indicated elevated risk (Table 1). After the study, the same surveillance protocols were implemented across the entire hospital.

Results
Risk adjusted mortality (using the UHC mortality model) fell 32% (Fig. 2) in the 9-months following the start of intervention as compared to the prior 9-months (historical control). In addition, there was a concurrent control group, 20 units comprising the remainder of the hospital, where risk-adjusted mortality, similar to the 11-unit treatment cohort prior to the study, was unchanged throughout the entire 18-month period. Studies following the controlled evaluation period showed that as the system was implemented across the whole hospital, overall hospital mortality decreased. Results could be deconstructed into two effects: 25% fewer patients falling to a “worrisome” acuity level indicated by an RI below 60 which accounted for 98% of hospital deaths, and a 16% lower mortality rate of those patients who did (Fig 3). Whole hospital mortality fell 37%. As such the beneficial effects generated by this protocolized surveillance affected patients across the acuity spectrum.

Discussion
To calibrate the reader, an RI value of 100 represents “unimpaired”. A value of 65 represents the acuity of a patient discharged to a skilled nursing facility, a value of 40 would warrant consideration for ICU transfer. Mortality rates for patients whose scores fall below 20 are about 25%, and for scores below 0, 50%. However, successful implementation starts with a timely signal but requires more. It is only through the modification of clinicians’ behavior as evidenced by integration into daily workflow that outcomes are affected. It was the combination of the RI technology with appropriate processes and personnel, i.e. robust nursing-based protocols to ensure enhanced
surveillance, that resulted in the mortality reduction observed in the trial. When the results were available it was ethically required that these protocols needed to be and were implemented throughout the hospital, and then throughout the seven community hospitals within the larger hospital system. Patients across the acuity spectrum were impacted, with fewer patients deteriorating into an RI-defined worrisome state, and lower mortality rates for those who did deteriorate to worrying levels. The finding is that rather than responding to vital sign derangement indicative of imminent decompensation, protocols for intervention based upon subtle, early signs of deterioration, as measured by a broad-based acuity score, can reduce mortality and improve the general quality of care.

REFERENCES


Fig. 1. RI Graphs stratified by risk
Table 1. Roles of clinicians and protocols for warnings
Fig. 2. Mortality Index reduction following implementation. Risk-adjusted mortality decreased 32% (0.7 to 0.48), p-value < 0.001.

Fig. 3. Mortality Reduction, Study and Post-Study Deconstructed into 2 Effects: Reduced Mortality for Sick Patients, and Fewer Sick Patients.