Rule base system for identification of patients with specific critical care syndromes: The “sniffer” for acute lung injury

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Abstract. Early detection of specific critical care syndromes, such as sepsis or acute lung injury (ALI) is essential for timely implementation of evidence-based therapies. Using a near-real time copy of the electronic medical records (“ICU data mart”) we developed and validated custom electronic alert (ALI “sniffer”) in a cohort of 485 critically ill medical patients. Compared with the gold standard of prospective screening, ALI “sniffer” demonstrated good sensitivity, 93% (95% CI 90 to 95) and specificity, 90% (95% CI 87 to 92). It is not known if the bedside implementation of ALI “sniffer” will improve the adherence to evidence-based therapies and outcome of patients with ALI.

Introduction. Timely recognition and treatment of specific acute physiologic syndromes: acute lung injury (ALI), shock or sepsis are the key determinants of outcome of critical illness, regardless of underlying cause. However, recognizing many of these specific patterns is difficult, even for critical care experts. This is particularly true in elderly patients with multiple comorbidities. While current monitoring systems effectively monitor extremes in heart rate and blood pressure they lack the ability to recognize complex physiologic syndromes, many of which require a combination of changes in vital signs and specific laboratory and radiological findings. ALI is the typical example of a major health problem for which the effective treatment is commonly instituted too late or not at all. We have recently reported that 70% of patients with ALI in whom appropriate treatment was not instituted were in fact not recognized to have ALI. Advances in medical informatics and widespread implementation of electronic medical records have given us the opportunity to facilitate early recognition and treatment of specific critical care syndromes. Preliminary data suggests that electronic screening may be a useful tool for enrolling patients with ALI into a prospective research study. Using near-real time data feeds from our hospital laboratory system and the reports of emergency portable chest radiographs, we developed and tested an ALI electronic alert (ALI “sniffer”).

Methods. Microsoft SQL-based integrative database, “ICU data mart”, accumulated data within one hour from its entry into the electronic medical records and served as the main data source for rules development. ALI was defined according to standard consensus conference criteria. The electronic alert was triggered by the following combination of observations within a 24h period: 1) qualifying arterial blood gas analysis: the ratio of partial pressure of oxygen over inspired oxygen concentration (PaO2/FIO2) <300 and 2) qualifying chest radiograph report: free text Boolean query containing trigger words: (“bilateral” AND “infiltrate”) OR “edema”. Sensitivity and specificity of the electronic alert was determined against the gold standard of prospective assessment by trained study coordinator, blinded to the ALI electronic alert.

Results. From 485 consecutive patients admitted to the medical ICU of a tertiary center (after excluding 38 who denied research authorization) prospective screening identified 54 patients with ALI (11%). ALI electronic alert had a high sensitivity 93% (95% CI 90 to 95) and specificity 90% (95% CI 87 to 92) with a positive predictive value of 53% (95%CI 49 to 58) and a negative predictive value of 99% (95%CI 98 to 100). Likelihood ratio for positive result was 9.07 and for negative - 0.08. The main reasons for false positive alerts were cardiogenic pulmonary edema and atelectasis. The electronic tool identified patients with ALI within 24h from the onset in all cases.

Conclusions. We have demonstrated that automatic screening of electronic medical records accurately identifies patients who develop ALI in the medical ICU. It remains to be seen if the implementation of this tool at the bedside would improve the adherence to evidence-based treatments and overall outcome of patients with ALI. Success of such a tool would prompt the development of more sophisticated electronic screening tools for other major critical care problems such as shock, severe sepsis or acute renal failure.

References