The value of point-of-care testing in deteriorating ward patients

July 2014

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Point-of-care testing (POCT) for key laboratory variables may help clinicians assess the level of acuteness and the level of care necessary in the management of deteriorating ward patients.

We used a multibiomarker POCT panel including B-type natriuretic peptide (BNP), D-dimer, myoglobin (Myo), creatine kinase MB isoenzyme (CKMB) and troponin I (TnI) to assist clinicians in a rapid response team (RRT).

The multibiomarker POCT panel was positive for at least one marker in half the patients. In particular BNP and D-dimer had a good sensitivity of "for ICU admission" with a high negative predictive value (NPV). Both BNP and D-dimer also had a strong NPV for in-hospital mortality.

The combination of normal BNP and D-dimer levels completely ruled out ICU admission or death. Thus, normal BNP and D-dimer levels practically exclude subsequent need for ICU admission and hospital mortality.

The findings of our study support the notion that POCT analysis of selected biomarkers has clinical utility in the risk assessment of acutely deteriorating ward patients.

Serious adverse events (SAEs) affect many hospitalized patients and are preceded by physiological deterioration in most cases [1].

Rapid Response Systems [5] (RRS) have been introduced in several countries with the goal of preventing physiological deterioration from leading to serious adverse events.

Such RRS attempt to deliver critical care expertise to the bedside of ward patients in response to signs of

physiological instability. However, achieving the correct diagnosis and making the correct prognostic assessment can be difficult in these time-critical situations.

Moreover, in many hospitals, demand for intensive care beds exceeds supply and rationing of ICU beds is common [2].

Thus, a method to assist in triaging which patients require admission to ICU during or after a rapid response team (RRT) review is desirable [3].

The tools for measuring the accuracy of such triage have not been clearly defined [4], but being able to accurately predict the patient's prognosis is important [5].

Shortness of breath (SOB) is the most common trigger for RRT calls [6], accounting for one third of such activations.

Moreover, one in every three patient reviewed for respiratory distress does not survive hospital admission [7].

Achieving a rapid prognostic assessment in these patients would be particularly useful. Accordingly, we assessed a Point-of-Care Test (POCT) device which could be used at the bedside and provide information on B-type natriuretic peptide (BNP), D-dimer, myoglobin, CKMB mass and troponin I.

These five analytes encompass most of the factors that might participate in the pathogenesis of dyspnea as a trigger of RRT activation: heart failure, pulmonary embolism and myocardial ischemia.

We prospectively evaluated 100 consecutive RRT activation episodes over a 6-month period. The data were collected during daytime hours (08.00 to 17.00 hours) when an independent study investigator was available.

Clinicians were blind to the results of the tests. The primary goal of our study was to assess the predictive values of such POCT technology for in-hospital mortality and unplanned ICU admission.

Study findings

We studied 95 patients who received 100 MET (medical emergency team) reviews. Their mean age was 70.5 years and half of the patients were male. As expected, co-morbidities were common with 41 % of patients having a history of heart failure and 70 % having chronic kidney disease [13].

Of the study patients, 36 % were surgical. At the time of RRT activation, 44 % of patients had dyspnea and 24 % already had documented "Not For Resuscitation" (NFR) orders. Two patients were made "NFR" after RRT review.

The most common RRT activation triggers were respiratory distress (36 %), decrease in conscious state (25 %), hypotension (20 %) and tachycardia (14 %). The POCT panel was positive for at least one marker in 50 % of RRT episodes.

Fifteen patients were admitted to ICU after the RRT review. They had high mean BNP and D-dimer values. BNP and D-dimer values predicted ICU admission with a high sensitivity and carried a high negative predictive value (NPV).

Of the study cohort, 37 % of the patients died. BNP and D-dimer had a high NPV for mortality (Table I). When these two markers were combined, normal values for both were associated with a 100 % survival and 100 % freedom from ICU admission.

The three cardiac panel tests (TnI, Myo, CKMB) were positive simultaneously in only nine patients. Four of them died, three of them had a subsequently confirmed clinical diagnosis of acute coronary syndrome.

Only eight patients tested positive for all biomarkers. Of these, six were NFR (four died) and one was admitted to ICU. The remaining patient with all-panel positivity survived in the ward with a diagnosis of acute coronary syndrome.

Unplanned ICU admission	Sensitivity	Negative predictive value
BNP	0.79	0.90
D-dimer	0.93	0.92
Mortality		
BNP	0.86	0.82
D-dimer	0.94	0.88

TABLE I: Sensitivity and negative predictive value (rule-out effect) of BNP and D-dimer bedside point-of-care measurements during rapid response team review

Discussion

We assessed the ability of biomarkers from a triage POCT for dyspnea to predict ICU admission and mortality in a cohort of hospitalized patients reviewed by the RRT.

We found that, within the limitations of the small number of patients, BNP and D-dimer- tests had high sensitivity in predicting admission to ICU or death and achieved a high negative predictive value (NPV).

Studies of BNP and D-dimer levels in ICU [8] or emergency department patients [9] show that elevated BNP and D-dimer levels might offer prognostic information about mortality. However, this was the first study to assess the prognostic value of BNP and D-dimer concentrations tested with POCT in RRT review patients.

Several lines of evidence would suggest that such biomarkers may prove useful in this context.

For example, BNP is useful in the diagnosis of acute and chronic heart failure (common triggers of RRT calls) and helps differentiate them from other syndromes [10]. BNP can also guide treatment, reduce length of stay, resource utilization and mortality [11].

A number of RRT-relevant conditions increase BNP levels [12]. Similarly, only small amounts of D-dimer are found in healthy individuals but levels increase in conditions associated with degradation of fibrin, such as infection, cancer, surgery, and heart or kidney failure and thromboembolism; all states known to trigger RRT review.

More relevant to our study, D-dimer levels correlate with outcomes in a number of diseases and in critically illness. Additionally, D-dimer can be used to rule out venous thrombotic disease in emergency department patients with a negative predictive value of approximately 97 %.

Our study tested, for the first time, whether these biomarkers could be applied to the assessment of critically ill ward patients, who activated RRT review, and provide useful prognostic information. The results suggest some clinical utility in ruling out subsequent ICU admission or mortality.

Significance of study findings

Patients receiving RRT reviews are a heterogeneous cohort of patients at high risk of ICU admission or death. Tests that can rapidly identify patients who will require ICU admission and/or are likely to die would be useful. In particular, such information is vital to correct triage in an environment where ICU beds are a finite resource.

The presence of combined normal D-dimer levels and normal BNP values predicted no need for subsequent ICU admission or risk of death. This indicates that these biomarkers can be used to help triage RRT-call patients. Such information should logically make care more efficient, help reassure clinicians, confirm clinical impressions and minimize unnecessary use of ICU resources. Finally, such attempts to improve the performance of METs and the care of deteriorating ward patients reflect growing awareness of the imperfections of current hospital care systems and the ongoing efforts to improve them.

Future research should study the impact of making such POCT biomarker information available to clinicians at the bedside to assess how such information affects behavior. A randomized controlled study of biomarker-supported care vs. standard care may then become justified.

In conclusion, in a prospective study of POCT-based assessment during an RRT review for deteriorating ward patients, the presence of combined normal BNP and D-dimer levels practically ruled out subsequent ICU admission or death. Such patients can be safely triaged to remain in the ward and have negligible risk of death.

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