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Clinical Paper

Point-of-care testing during medical emergency team activations: A pilot study☆

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ABSTRACT

Objective: To estimate the prognostic value of point-of-care measurement of biomarkers related to dyspnea in patients receiving a medical emergency team (MET) review.
Design: Prospective observational study.
Setting: University affiliated hospital.
Patients: Cohort of 95 patients receiving MET review over a six month period.
Methods: We used a commercial multi-biomarker panel for shortness-of-breath (SOB panel) (Biosite Triage Profiler, Biosite Incorporated®, 9975 Summers Ridge Road, San Diego, CA 92121, USA) including Brain natriuretic peptide (BNP), D-dimer, myoglobin (Myo), creatine kinase MB isoenzyme (CK-MB) and troponin I (Tn-I). We recorded information about demographics, MET review triggers, and MET procedures and patient outcome.
Results: Mean age was 70.5 (±15) years, 38 (41%) patients had a history of chronic heart failure (CHF) and 67 (70%) chronic kidney disease (CKD). At MET activation, 42 (44%) patients were dyspneic. The multi-biomarker panel was positive for at least one marker in 48 (51%) cases. BNP and D-dimer had a sensitivity of 0.79 and 0.93 for ICU admission with a negative predictive value (NPV) of 0.89 and 0.92 respectively. Thirty-five (37%) patients died. BNP was positive in 85% of such cases with sensitivity and NPV of 0.86 and 0.82, respectively. D-dimer was positive in 77% of non-survivors with a sensitivity and NPV of 0.94 and 0.88, respectively. BNP (area under the curve of receiver operating characteristic curve – AUC-ROC: 0.638) and D-dimer (AUC-ROC: 0.574) achieved poor discrimination of subsequent death. Similar findings applied to ICU admission. The combination of normal BNP and D-dimer levels completely ruled out ICU admission or death. The cardiac part of the panel was not useful in predicting ICU admission or mortality.
Conclusions: Although, BNP and D-dimer are poor discriminants of ICU admission and hospital mortality, normal BNP and D-dimer levels practically exclude subsequent need for ICU admission and hospital mortality.

1. Introduction

Serious adverse events (SAEs) are common in hospitalized patients and are typically preceded by physiological deterioration.[1–4] To prevent SAEs, rapid response systems[5] (RRS) have been introduced in several countries. These systems aim to deliver critical care expertise toward patients in response to signs of physiological instability. However, diagnosis and prognosis can be difficult in these time-critical situations. Moreover, in many hospitals, where demand for intensive care beds exceeds supply, rationing of ICU beds is common.[6,7] Thus a method to assist in triaging the site of further care of MET call patients is desirable.[8–12] The tools for measuring the accuracy of such triage have not been clearly defined,[13,14] but being able to accurately predict the patient's prognosis is important.[15]

Shortness of breath (SOB) is the most common trigger of a MET review,[16,17] accounting for one-third of such activations with one in every three patient reviewed for respiratory distress dying.[18,19] Achieving a rapid prognostic assessment in these patients would be particularly useful. Accordingly, a point-of-care test (POCT) which could be performed at the bedside (Biosite Triage Profiler, Biosite Incorporated®, 9975 Summers Ridge Road, San Diego, CA 92121, USA) was introduced at our institution to help the MET evaluate such patients. In particular, brain natriuretic peptide (BNP) helps diagnose and prognosticate in patients with acute cardiac failure,[23,24] D-dimer can help rule out pulmonary embolism,[20–22] and myoglobin, CK-MB fraction and troponin-I are known biomarkers used in the diagnosis of acute coronary syndromes.[25,26]

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Table 1
Criteria used to trigger a MET activation at the Austin Hospital.

Airway	Airways obstruction Stridor, noisy breathing Problems at managing tracheostomy tube
Breathing	Dyspnea Respiratory rate < 8 min Respiratory rate > 25 min SpO_2 < 90%
Circulation	Heart rate < 40 min Heart rate > 120 min Hypotension (systolic pressure < 90 mmHg) Urinary output < 50 mL/h over 4 h
Neurological change	Acute change in conscious state Unrousable patient
Staff worried	If there is any concern about the patient by the ward staff not included in above mentioned criteria

Accordingly, we conducted a pilot study of the clinical utility of such POCT device in a cohort of patients receiving a MET call in our hospital. We hypothesized that such tests would provide good discrimination in identifying non-survivors and patients requiring subsequent ICU admission and would help identify patients with a low risk of subsequent ICU admission or death.

2. Methods

The collection and analysis of data related to MET activities and its submission for publication were approved by the hospital's Human Research Ethics Committee that waived the need for written informed consent.

The Austin and Repatriation medical center comprises two major teaching hospital campuses affiliated with the University of Melbourne: one for acute care and the other for long-term care patients. The acute care campus admits about 60,000 patients per year and has 21 intensive care unit (ICU) beds. About 2100 patients are admitted to ICU each year. The medical emergency team (MET) system has been operating in the Austin Hospital since September 2000. It is structured so that any member of the hospital staff can activate it. The MET consists of an on-duty intensive care fellow and a designated intensive care nurse. In the years since initiation of the system, MET reviews have decreased the number of in-hospital cardiac arrests and lowered overall hospital mortality.[27] The MET response is activated by a number of pre-determined criteria (see Table 1) that are well known to all health staff within the hospital. MET activation can be made by both doctors and nurses through the switchboard operators.

We prospectively evaluated 100 consecutive MET episodes over a six month period. The data were collected during daytime hours (08.00–17.00 h) when an independent study investigator was available. Clinicians were blind to the results of the tests.

The Biosite Triage Profiler® SOB is a panel of test for pulmonary edema, pulmonary embolism and myocardial ischemia measuring BNP, D-dimer, Myo, CK-MB and Tn-I using a spectrophotometric technique. This POCT multimarker panel for SOB performs blood test analysis for these 5 biomarkers giving information in 15 min. Positive cut-off values are as follow: BNP > 100 ng/mL, D-dimer > 400 ng/mL, Myo > 107 ng/mL, CK-MB > 4.3 ng/mL and Tn-I > 0.4 ng/mL. The Biosite Triage Profiler® SOB panel is a bedside test with built-in test control, that requires 250 μL of whole blood or plasma.

2.1. Outcome measures

The primary outcome measure was predictive values of POCT analytes for in hospital mortality. The secondary outcome was the predictive value of the POCT analytes for unplanned ICU admission.

2.2. Statistical analysis

Individual patients were considered for analysis. Continuous variables are reported as mean ± standard deviation (SD). All comparisons were unpaired and two tailed. Non-parametric variables were compared using the Mann–Whitney test. Normally distributed continuous variables were analyzed with Student's *t*-test. For continuous data that demonstrated a nonparametric distribution, we applied the Kruskal–Wallis test. Fisher's exact test was used to compare categorical variables. We used the area under curves (AUCs) to identify the ability of a test to discriminate between two different outcomes. We measured sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). Statistical analyses were performed using software SPSS version 18.0.3 for Mac (SPSS, Chicago, IL, USA). A p value less than 0.05 was considered significant.

3. Results

We studied 95 patients who received 100 MET reviews. Their mean age was 70.5 (±15) years and 48 (51%) were male; 39 patients (41%) had a history of chronic cardiac failure and 66 (70%) had renal impairment.[28] Thirty-four patients (36%) were surgical. At the time of MET activation, 42 (44%) patients were dyspneic and 23 (24%) were already 'Not For Resuscitation' (NFR). Two patients were made 'NFR' after MET activation. The MET activation triggers were as follows: respiratory distress (36%), decrease in conscious state (25%), hypotension (20%) and tachycardia (14%). The Biosite SOB panel was positive for at least one marker in 50% of MET episodes. The results are summarized in Table 2. The number of patients with a positive BNP test was significantly greater in patients with

Table 2
Mean values for multimarker panel in overall study population and in specific subgroups of patients. Values are mean (±standard deviation).

	BNP (ng/mL)	D-dimer (ng/mL)	Myoglobin (ng/mL)	CK-MB (ng/mL)	Troponin I (ng/mL)
Total (95 patients)	595 (±815)	2253 (±1549)	218 (±173)	4.4 (±7.5)	0.15 (±0.68)
Medical (61 patients)	582 (±838)	2214 (±1572)	190 (±155)	3.7 (±6.3)	0.78 (±0.33)
Surgical (34 patients)	611 (±790)	2309 (±1534)	268 (±191)	5.5 (±9.2)	0.28 (±1.02)
NFR (25 patients)	615 (±824.4)	2340 (±1517)	255 (±185)	8 (±11.8)	0.34 (±1.16)
Not-NFR (70 patients)	560 (±843)	2117 (±1559)	203 (±166.)	3.4 (±3.8)	0.08 (±0.32)
Not-NFR died	422 (±635.7)	2133 (±4950)	271 (±198)	3.1 (±3.8)	0.06 (±0.84)
Renal failure (66 patients)	756 (±937)	2466 (±1554)	248 (±175)	4.5 (±7.5)	0.23 (±0.83)
Chronic HF (39 patients)	817 (±911)	2160 (±1493)	274 (±183)	4.9 (±8.7)	0.26 (±1)
Not renal and cardiac failure	217 (±87)	1721 (±282)	153 (±149)	5 (±8.9)	0.02 (±0.02)
ICU admitted (15 patients)	479 (±589)	2280 (±1715)	223 (±192)	3.1 (±4.8)	0.27 (±0.34)
Died in ICU	889.4 (±1097)	1976 (±1738)	200 (±192)	3.1 (±6.1)	0.11 (±0.01)
Survived (60 patients)	476 (±677)	2086 (±1501)	201 (±162)	4.1 (±7.5)	0.2 (±0.84)
Died (35 patients)	821 (±1016)	2539 (±1611)	256 (±192)	5.1 (±7.7)	0.77 (±0.14)