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Research Paper

Early warning score: An indicator of adverse outcomes in postoperative patients on a gynecologic oncology service☆

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HIGHLIGHTS

- No patients with EWS < 5 had the composite outcome compared to 32.6% with EWS ≥ 8.
- Patients with high EWS required longer LOS and more readmissions and transfusions.
- EWS ≥ 8 had 56.0% sensitivity and 92.5% specificity for the composite outcome.

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ABSTRACT

Objective. In 2014, our hospital implemented an early warning score (EWS) to identify inpatients at risk for clinical deterioration. EWS ≥ 8 is associated with ≥10% mortality in medical admissions. Since postoperative hemodynamic changes may alter EWS, we evaluated EWS in post-laparotomy patients.

Methods. Gynecologic oncology patients admitted for laparotomy from 9/1/2014 to 7/31/2015 were categorized by highest EWS during admission: <5, 5–7, and ≥8. The primary outcome was a composite including death, ICU transfer, rapid response team activation, pulmonary embolus, sepsis, and reoperation. For patients with the composite, highest EWS prior to that outcome was evaluated. Secondary outcomes were length of stay (LOS), readmission, and transfusion. Groups were compared using chi-square test for trend, analysis of variance, and Kruskal-Wallis tests. A receiver operating characteristic (ROC) curve estimated the association between EWS and the composite outcome.

Results. 411 patients were included: 217 (52.8%) with EWS < 5, 151 (36.7%) with EWS 5–7, and 43 (10.5%) with EWS ≥ 8. The composite occurred in 32.6% of patients with EWS ≥ 8, 7.3% with EWS 5–7, and 0% with EWS < 5 ($p < 0.01$). EWS ≥ 8 was associated with longer LOS, higher readmission rate, and more transfusions. For the composite, the area under the ROC curve was 0.89 (95% CI 0.84–0.94). EWS ≥ 5 had 100% sensitivity and 56.2% specificity for the primary outcome; EWS ≥ 8 had 56.0% sensitivity and 92.5% specificity for the primary outcome.

Conclusions. EWS ≥ 5 after laparotomy is associated with adverse outcomes. Future studies should evaluate the ability of EWS to predict and prevent these outcomes.

1. Introduction

Failure to recognize clinical deterioration in acutely ill patients is a major cause of inpatient mortality [1]. The monitoring of vital signs and clinical status is intended to detect such deterioration and in turn prompt an appropriate clinical intervention [2]. Physiologic track and trigger systems, also known as early warning systems, were developed with a goal of identifying deteriorating patients and prompting earlier physician evaluation and more timely escalation of care [3]. These

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systems allocate points based on degree of derangement in vital signs and level of consciousness. The resulting score can be used to trigger interventions such as physician assessment and increased frequency of vital sign monitoring [3–5]. Early warning systems based on aggregate trigger thresholds have been shown to maintain the highest sensitivity and specificity [6].

The Joint Commission mandates that hospitals identify early warning signs of a change in a patient's condition and how to respond to a deteriorating patient [7]. This directive parallels efforts by the National Institute for Health and Care Excellence (NICE) in Great Britain, who issued a recommendation in 2007 that early warning systems should be used to monitor all adult patients in the acute hospital setting [8]. The National Early Warning System (NEWS) adopted by the Royal College of Physicians includes heart rate, systolic blood pressure, respiratory rate, oxygen saturation, need for supplemental oxygen, and level of alertness [5]. In acute medical admissions, an early warning score (EWS) ≥5 has been associated with increased risk of mortality, and an EWS ≥ 8 has been associated with a mortality risk of >10% [5].

While various EWS algorithms have been validated among medical and critical care admissions, their application to other patient populations has proven challenging. Gynecologic oncology patients may manifest postoperative changes related to disease status, surgical procedures performed, hemodynamic changes, inflammation, and pain. Due to the potential for these variables to influence the EWS, we evaluated the association between elevated EWS and serious adverse outcomes after laparotomy in gynecologic oncology patients.

2. Methods

2.1. Study design

This single-institution retrospective cohort study was approved by the Institutional Review Board at the University of Alabama at Birmingham. Hospital data identified all patients admitted to the gynecologic oncology service who had a laparotomy for any indication from 9/1/14 to 7/31/15. Patients with planned ICU admissions or those admitted directly to the ICU from the operating room were excluded. The electronic medical record (EMR) of each patient was reviewed to obtain demographic information, primary diagnosis, medical history, and procedure performed.

2.2. Early warning score

The EWS system adopted by our hospital is based on the NEWS adopted by the Royal College of Physicians in the United Kingdom and includes temperature, heart rate, blood pressure, respiratory rate, oxygen saturation, need for supplemental oxygen, and mental status (Table 1) [5]. Using the EMR, an EWS is automatically calculated with each recorded set of vital signs. The EMR is programmed to review the vital signs from the past 6 h to account for absent components and calculate an aggregate EWS. An EWS ≥ 5 triggers a physician assessment and increased frequency of vital sign monitoring, while an EWS ≥ 8 triggers a rapid response team (RRT) nurse evaluation in addition to those interventions. The RRT nurse evaluation ensures that the primary team is evaluating the patient in a timely fashion and pursuing an appropriate workup. If it is determined that the patient needs a higher level of care, the RRT nurse can facilitate full RRT activation and escalation to higher level of care as needed.

The medical record of each patient was reviewed to determine the highest EWS recorded during her postoperative admission. For patients with the composite outcome, the highest EWS prior to the first composite event was used for the analysis rather than the highest EWS over the admission. Based on the pre-determined responses to the EWS, patients were divided into three cohorts: EWS < 5, EFW 5–7, and EWS ≥ 8. In addition, the mean EWS was calculated for the day of the composite event for the two preceding days to evaluate whether EWS significantly increased in the days prior to an adverse event.

2.3. Outcomes

The primary outcome was a composite of mortality and significant morbidity that included death, unplanned ICU transfer, RRT activation, pulmonary thromboembolus (PTE), postoperative sepsis, and reoperation. Patients with planned ICU admissions or patients admitted directly to the ICU from the operating room were excluded. RRT activation consisted of a full team assessment, which is a separate process than the RRT nurse evaluation described above for patients with EWS ≥ 8. Secondary outcomes included length of stay (LOS), 30-day readmission, and need for postoperative transfusion.

2.4. Statistical analysis

Groups were compared using chi-square test for trend for categorical variables and Kruskal-Wallis or analysis of variance tests for continuous variables. Statistical significance was set at $P < 0.05$. The area under the receiver operating characteristic (AUROC) curve was calculated to visually assess the relationship between EWS and the primary outcome. The sensitivity and specificity of an EWS ≥ 5 and ≥8 for the composite outcome was determined. All statistical analysis was performed using STATA SE, version 13 (Stata Corp LP, College Station, TX).

3. Results

424 gynecologic oncology patients underwent a laparotomy during the study period. 13 of these patients had planned ICU admissions or were admitted to the ICU immediately postoperatively and were excluded, leaving a cohort of 411 eligible patients. 217 patients (52.8%) had a highest EWS < 5, 151 patients (36.7%) had a highest EWS of 5–7, and 44 patients (10.5%) had a highest EWS ≥ 8. Basic demographic information for the patients is shown in Table 2. Increasing age, cancer diagnosis and stage, liver disease, and bowel surgery as part of the primary procedure were significantly associated with elevated EWS (Table 2). BMI, comorbidities other than liver disease, and other common surgical procedures were not statistically different among groups (Table 2).

One or more of the composite outcomes occurred in 25 (6.1%) subjects, including 10 ICU transfers, 9 postoperative sepsis diagnoses, 7 RRT activations, 4 PTEs, 3 reoperations, and 2 deaths. No patients with

Table 1
Early Warning Score (EWS).

	3	2	1	0	1	2	3
Respiratory rate	≤8	–	9–11	12–20	–	21–24	≥25
Oxygen saturation (%)	≤91	92–93	94–95	≥96	–	–	–
Supplemental oxygen	–	–	–	No	–	Yes	–
Temperature (F)	≤95	–	95.1–96.8	96.9–100.4	100.5–102.2	≥102.3	–
Systolic blood pressure (mmHg)	≤90	91–100	101–110	111–219	–	–	≥220
Heart rate	≤40	–	41–50	51–90	91–110	111–130	≥131
Level of consciousness	–	–	–	A	–	–	V,P,U

Level of consciousness: A = alert, V = responds to voice, P = responds to pain, U = unresponsive.