



# Early Warning System Scores: A Systematic Review

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## PREFACE

Quality Enhancement Research Initiative's (QUERI) Evidence-based Synthesis Program (ESP) was established to provide timely and accurate syntheses of targeted healthcare topics of particular importance to Veterans Affairs (VA) managers and policymakers, as they work to improve the health and healthcare of Veterans. The ESP disseminates these reports throughout the VA.

QUERI provides funding for 4 ESP Centers and each Center has an active VA affiliation. The ESP Centers generate evidence syntheses on important clinical practice topics, and these reports help:

- develop clinical policies informed by evidence,
- guide the implementation of effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures, and
- set the direction for future research to address gaps in clinical knowledge.

In 2009, the ESP Coordinating Center was created to expand the capacity of QUERI Central Office and the 4 ESP sites by developing and maintaining program processes. In addition, the Center established a Steering Committee comprised of QUERI field-based investigators, VA Patient Care Services, Office of Quality and Performance, and Veterans Integrated Service Networks (VISN) Clinical Management Officers. The Steering Committee provides program oversight, guides strategic planning, coordinates dissemination activities, and develops collaborations with VA leadership to identify new ESP topics of importance to Veterans and the VA healthcare system.

Comments on this evidence report are welcome and can be sent to Nicole Floyd, ESP Coordinating Center Program Manager, at [nicole.floyd@va.gov](mailto:nicole.floyd@va.gov).

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## EXECUTIVE SUMMARY

**Background:** Recognizing early signs of clinical deterioration of hospitalized patients is thought to improve patient outcomes by activating more attentive care in a timely fashion. Early warning system scores are tools used by care teams to potentially predict a patient's risk of deterioration and facilitate changes in management.

**Objective:** To systematically review the evidence on the predictive ability of Early Warning System (EWS) scores and the impact of EWS interventions on health and resource related outcomes.

**Data Sources:** MEDLINE, CINAHL, and Cochrane Library through April 2013 and hand search of reference lists.

**Study Selection:** Independent dual review to identify English language studies of early warning systems tested with adult patients admitted to medical or surgical wards. Non-systematic reviews, opinions, and case series were excluded.

**Data Extraction:** Data were extracted by 2 reviewers on the population, setting, sample size, duration, model discrimination and calibration, health outcomes, and resource utilization. Quality was assessed as applicable using a modified version of the Quality in Prognosis Studies (QUIPS) assessment tool for observational studies. For predictive ability, primary outcomes were model discrimination on 48-hour mortality, cardiac arrest, or pulmonary arrest. Outcomes for impact of EWS implementation included 30-day mortality, cardiovascular events, use of vasopressors, number of ventilator days, respiratory failure, and resource utilization.

**Results:** Of 13,595 citations reviewed, 17 studies of 11 unique models met criteria. All were based on some combination of vital signs and clinical evaluation. Six observational studies tested in large urban hospitals in developed countries found a strong predictive value for death (AUROC 0.88-0.93) and cardiac arrest (AUROC 0.77-0.86) within 48 hours. Eleven observational cohort studies with historical controls provided evidence on the impact of EWS implementation but were insufficient to draw firm conclusions due to methodological limitations.

**Conclusions and Relevance:** Current early warning system scores perform well for predicting cardiac arrest and death within 48 hours although the impact on health outcomes and utilization of resources remains uncertain. Efforts to more rigorously assess their performance and effectiveness are needed as use becomes more widespread.