Evidence-based Synthesis Program (ESP)

Early Warning System Scores

A Systematic Review of the Evidence

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Disclosure

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Evidence-based Synthesis Program (ESP)

VA Evidence-based Synthesis (ESP) Program Overview

- **Sponsored by VA Office of R&D and Quality Enhancement Research Initiative (QUERI).**
- **Established to provide timely and accurate syntheses/reviews of healthcare topics identified by VA clinicians, managers and policy-makers, as they work to improve the health and healthcare of Veterans.**
- **Builds on staff and expertise already in place at the Evidence-based Practice Centers (EPC) designated by AHRQ. Four of these EPCs are also ESP Centers:**
  - Durham VA Medical Center; VA Greater Los Angeles Health Care System; Portland VA Medical Center; and Minneapolis VA Medical Center.

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- **Provides evidence syntheses on important clinical practice topics relevant to Veterans, and these reports help:**
  - develop clinical policies informed by evidence,
  - the implementation of effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures, and
  - guide the direction for future research to address gaps in clinical knowledge.
- **Broad topic nomination process – e.g. VACO, VISNs, field – facilitated by ESP Coordinating Center (Portland) through online process:**

http://www.hsrd.research.va.gov/publications/esp/TopicNomination.cfm

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- **Steering Committee representing research and operations (PCS, OQP, ONS, and VISN) provides oversight and guides program direction.**
- **Technical Expert Panel (TEP)**
  - Recruited for each topic to provide content expertise.
  - Guides topic development; refines the key questions.
  - Reviews data/draft report.
- **External Peer Reviewers & Policy Partners**
  - Reviews and comments on draft report
- **Final reports posted on VA HSR&D website and disseminated widely through the VA.**

http://www.hsrd.research.va.gov/publications/esp/reports.cfm

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Early Warning System Scores

A Systematic Review

(November, 2013)

Full-length report available on ESP website:

http://www.hsrd.research.va.gov/publications/esp/reports.cfm

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Overview of Today's Presentation

- Background
- Scope of the review
- Results
- Limitations
- Future research
- Questions and Answers

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Background

- Early warning system scores are tools used by hospital care teams
- Based on physiologic parameters for composite score
- Observations studies suggest that patients often show signs of clinical deterioration up to 24 hours prior to a serious clinical event
- Uncertainty exists around the utility of recognizing early signs of clinical deterioration and whether early intervention and management makes a difference in patient outcomes

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Background

- Plans for implementing the Modified EWS (MEWS) nationally through the VA
- This report is to provide evidence to the Office of Nursing Services Clinical Practice Programs ICU workgroup to develop guidelines for implementation and identify gaps in knowledge

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Scope of the Review: Key Questions

- **Key Question 1**
  - In adult patients admitted to the general medicine or surgical wards, what is the predictive value of EWS scores for patient health outcomes within 48 hours of data collection, including short-term mortality (all cause or disease specific), and cardiac arrest?
  - Which factors contribute to the predictive ability of EWS scores, and does predictive ability vary with specific subgroups of patients?

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Key Questions

- **Key Question 2 a**
  - In adult patients admitted to the general medicine or surgical wards, what is the impact of using Early Warning Systems on patient health outcomes including 30-day mortality, cardiovascular events, use of vasopressors, number of ventilator days, and respiratory failure?
- **Key Question 2 b**
  - In adult patients admitted to the general medicine or surgical wards, what is the impact of using Early Warning Systems on resource utilization including but not limited to admissions to the intensive care unit (ICU), length of hospital stay, and use of Rapid Response Teams (RRT)?

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Scope of the Review: Inclusion Criteria

Patients: Adults admitted to the medicine or surgical wards

Intervention: any early warning system score

Comparator: alternate system score or usual care

Outcomes:

KQ1: Mortality, cardiac arrest, pulmonary arrest within 48 hours of data collection

KQ2: 30- day mortality, cardiovascular events (cardiac arrest, acute coronary syndrome and cardiogenic shock), use of vasopressors, number of ventilator days, respiratory failure and length of hospital stay

Study design:

KQ1: Observational studies

KQ2: controlled trials and observational studies

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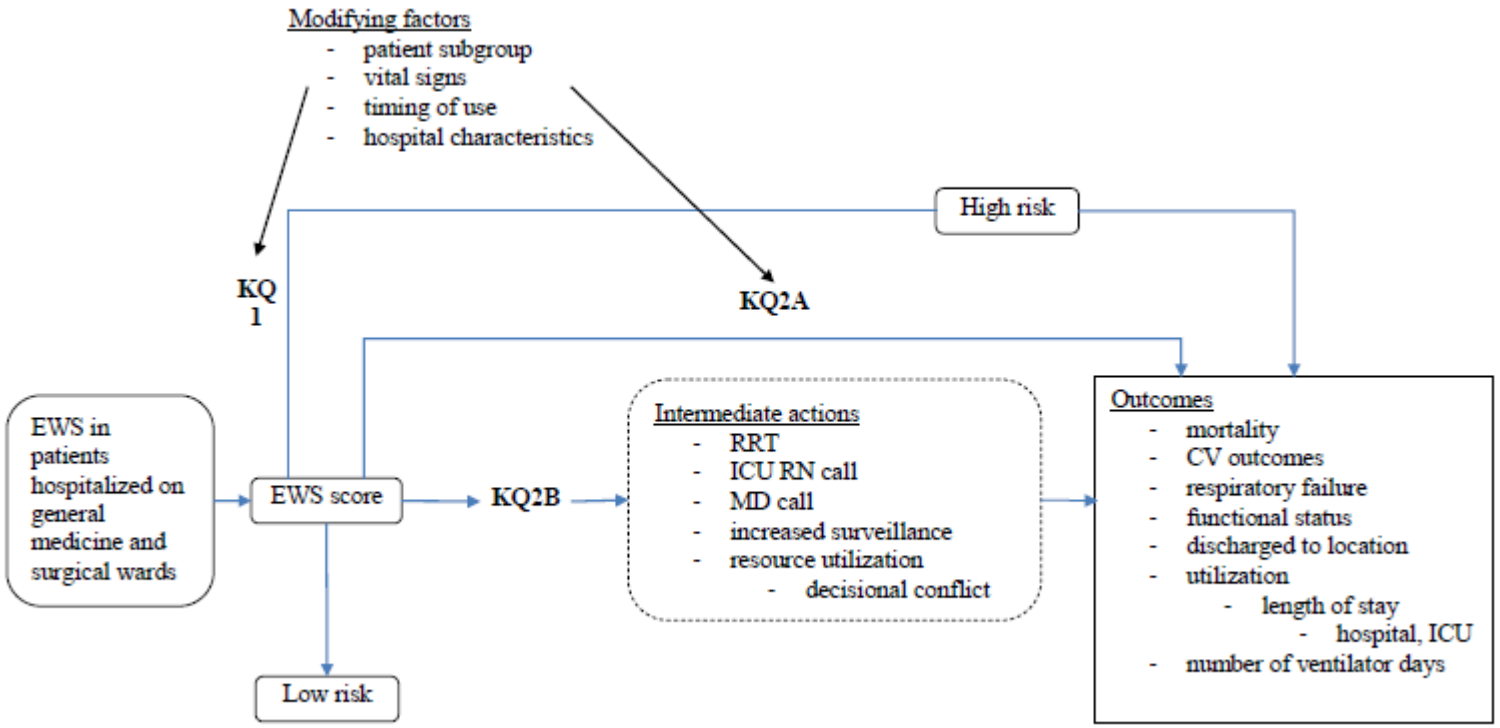
Scope of the Review: Analytic Framework



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Scope of the Review: Exclusions

- Non-English language
- Non-adult study population
- Non-medicine or surgical wards for KQ2 (for predictive ability, we included the emergency department)
- No primary data (e.g., editorials), case series or non-systematic review article
- Outcomes not in scope

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Methods

- **Search of databases (April 2013, updated October 2013)**
  - MEDLINE
  - Cochrane library Database of Systematic Reviews and Central Register of Controlled Trials
  - Clinicaltrials.gov
  - FDA premarket notification 510(k) summaries
  - Conference proceedings of ophthalmologic societies and topic specific journals
  - Additional articles and reviews obtained from reference lists and reviewers
- **Data abstraction -** population, setting, sample size, duration, model discrimination and calibration, health outcomes, and resource utilization
- **Assessment of study quality -** Quality in Prognosis Studies (QUIPS) tool for observational studies
- **Review of evidence:** qualitative synthesis

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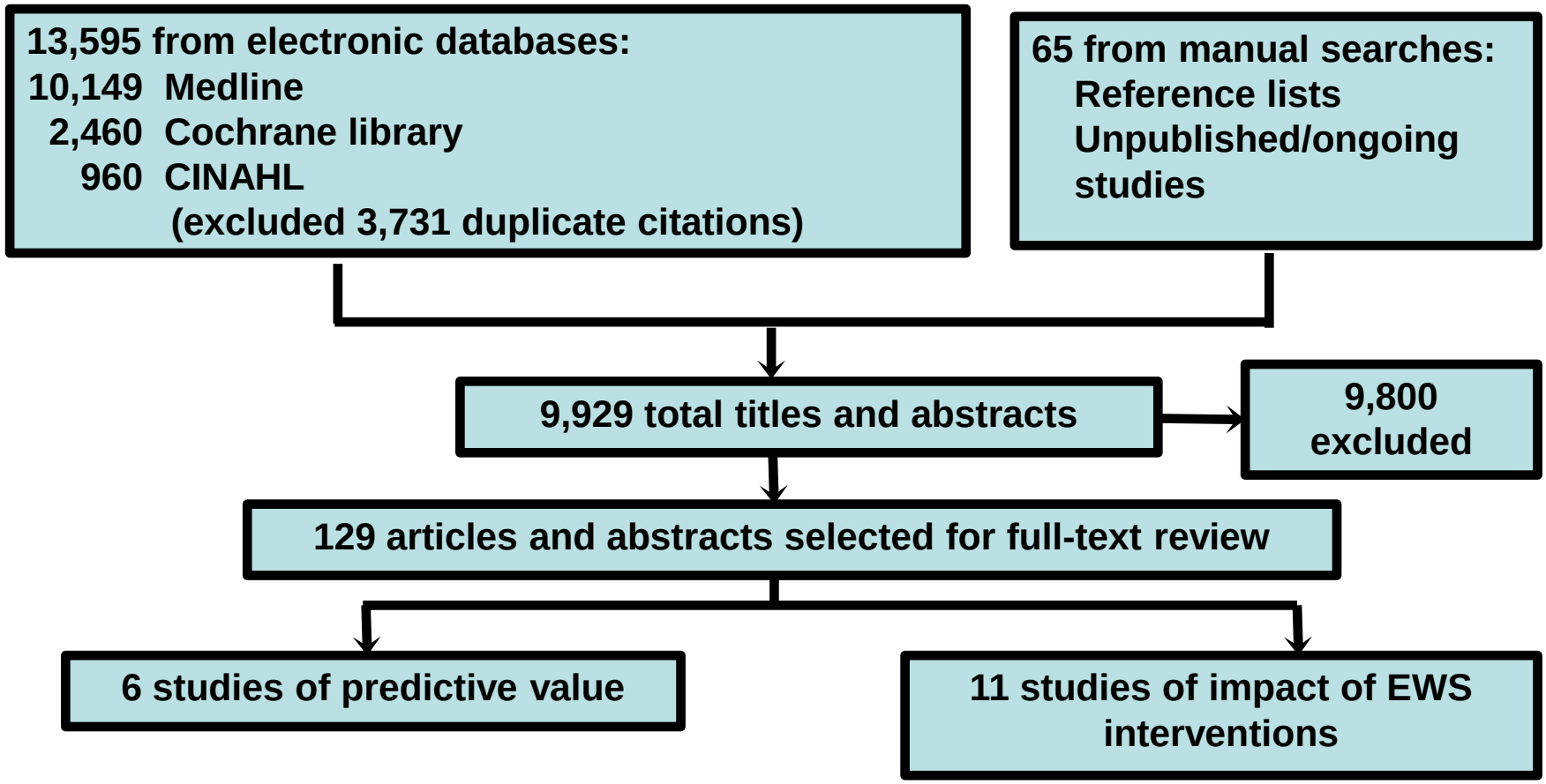
Results: Search Yield



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Poll Question
(Pick one answer)

What best describes your professional training?

1. Nurse
2. Provider
3. Administration
4. Other

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Poll Question: What best describes your experience with EWSS?

1. Nurse with experience using EWSS
2. Provider with experience using EWSS
3. Nurse or provider considering using EWSS
4. Administrator considering use of EWSS
5. Other

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Results: Key Question 1

What is the predictive value of EWS scores for patient health outcomes within 48 hours of data collection?

- Six observational studies (2 prospective cohort, 2 case-control) including 4 distinct models reporting on death and cardiac arrest within 48 hours of measurement

- 3 USA, 2 UK, 1 Canada

- One study – single predictors; models ranged from 4-7 items, all including HR, RR, BP, and most including temp and mental status
  - CART, MEWS, NEWS, ViEWS (6 and 7-item)

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Study Country	N parameters; name of scoring system	Parameters used in the system scores										
		Heart rate	Resp rate	SBP	Temp	Urine output	O2 Sat	Difficulty breathing	Supp O2	Mental Status (LOC)	Concern	Other, specify
Rothschild, 2010[8] USA	Single items, not combined	X	X	X	X	X	X	---	X	X	X	DBP, seizures, uncontrolled bleeding, color change
Churpek, 2012[9] USA	4-item CART	X	X	---	---	---	---	---	---	---	---	DBP, Age
Churpek, 2012[13] USA	5-item MEWS	X	X	X	X	---	---	---	---	X	---	---
Kellett, 2012[18] Canada	6-item ViEWS	X	X	X	X	---	X	---	X	---	---	---
Smith, 2013[22] UK	7-item NEWS	X	X	X	X	---	X	---	X	X	---	---
Prytherch, 2010[23] UK	7-item ViEWS	X	X	X	X	---	X	---	X	X	---	---

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Results: Key Question 1

What is the predictive value of EWS scores for patient health outcomes within 48 hours of data collection?

- Strong predictive ability for death (AUROC 0.88 - 0.93) and cardiac arrest (AUROC 0.77 – 0.86) within 48 hours
- Lower scores associated with a very good prognosis
- Higher scores corresponded to higher rates of adverse outcomes but sensitivity poor (at a specificity of 90%, sensitivity ranged from 48% -67%)
- No differences based on subsets of patients in terms of sex, year of admission, age, indication for admission, and diagnosis (based on 1 study)

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Results: Key Question 1

Which factors contribute to the predictive ability of EWS scores and does predictive ability vary with specific subgroups of patients?

- One case-control study (n=262 vs n=318)
- Cardiac arrest within 8 hours
- Criteria most associated with a life-threatening event included respiratory rate >35 (OR 31.1, 95% CI, 7.5-129.6), need for supplemental oxygen to 100% or use of a non-rebreathing mask (OR 13.7, 95% CI 5.4- 35), and heart rate >140/minute (OR 8, 95%CI 2.4-27.5)
- Multiple positive criteria were more common in cases than controls (≥3 positive criteria, 23 vs 16, p=0.00027).

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Results: Key Question 1

- Limited by potential for risk of bias due to study designs – 4 were derivation studies which are at risk of 'over-fitting' data to the population ; 2 were case-control studies which s are at risk of the groups receiving different exposures to the intervention (i.e., vital sign measurement)

- Predictive ability of one system over another: INSUFFICIENT
- Which factors contribute most: INSUFFICIENT

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Results: Key Question 2A

What is the impact of using Early Warning Systems on patient health outcomes?

- 11 observational cohort studies with historical controls (n=89 to >200k) addressing outcomes of mortality and cardiac arrest
- EWS models ranging from 5-12 items (all included HR, RR, SBP; most included LOC or mental status, temp, and urinary output)
- 5 UK, 2 USA, 1 Australia, 1 Belgium

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Study Country	N parameters; name of scoring system	Parameters used in the system scores										
		Heart rate	Resp rate	SBP	Temp	Urine output	O2 Sat	Difficulty breathing	Supp O2	Mental Status (LOC)	Concern	Other, specify
Maupin, 2009[10] USA	5-item MEWS	X	X	X	X	---	---	---	---	X	---	---
Jones, 2011[11] UK	Patientrack EWS	X	X	X	X	---	---	---	---	X	---	---
Subbe, 2003[12] UK	5-item MEWS	X	X	X	X	---	---	---	---	X	---	---
O'Dell, 2002[14] UK	5-item MEWS	X	X	X	---	X	---	---	---	X	---	---
DeMeester, 2012[15] Belgium	6-item MEWS	X	X	X	X	---	X	---	---	X	---	---
Smith, 2006[16] UK	6-item EWS	X	X	X	X	X	---	---	---	X	---	---
Patel, 2011[17] UK	6-item MEWS	X	X	X	X	X	---	---	---	X	---	Catheterized
Mitchell, 2010[19]	7-item MEWS	X	X	X	X	X	X	---	---	X	---	---
Moon, 2011[20] UK	7-item MEWS	X	X	X	X	X	X	---	---	X	---	---
Green, 2006[21] Australia	7-item clinical marker tool	X	X	X	---	X	X	X	---	---	X	---
Albert, 2011[24] USA	12-item MEWS	X	X	X	X	X	X	X	X	X	X	WBC; new focal weakness

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Results: Key Question 2A - Mortality

What is the impact of using Early Warning Systems on patient health outcomes?

- 6 studies – mixed results

- 5 found a decrease in overall mortality with only one finding statistical significance
  - Deaths per hospital admission decreased from 1.4% to 1.2% ($p<0.0001$)
  - Deaths per cardiac arrest call decreased from 26% to 21% ($p<0.0001$)
  - Deaths of patients admitted to ICU having undergone CPR decreased from 70% to 40% ($p<0.0001$)

- 1 study found a non-significant increase in overall mortality
  - For patients who were spontaneously breathing with a pulse at time of 'code blue' call, there was a significant improvement in survival (59% to 75%, $p=0.0003$)

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Results: Key Question 2A – Cardiac Arrest

What is the impact of using Early Warning Systems on patient health outcomes?

- 3 studies – mixed results
- 1 found a decrease in 2 hospitals (0.4% to 0.2%, $p<0.001$; 0.34% to 0.28%, $p<0.001$)
- 1 found no difference in patients who scored low (0/15-2/15) or high (5/15-15/15) but found an increase in moderate (5% vs 0%, $p<0.016$)
- 1 study reported a decrease in number of cardiac arrest among 'code blue' calls (52.1% vs 35%, $p=0.024$)

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Results: Key Question 2B

What is the impact of EWS on resource utilization?

Length of Hospital Stay:

- 3 studies – mixed results
  - 1 study found no difference, 1 study found a decrease, 1 study found an increase

Admissions to ICU:

- 5 studies – mixed results
  - 2 studies found an increase, 1 study (2 hospitals) found a decrease
  - 2 studies found no difference in length of ICU stay

Use of Rapid Response and Code Teams:

- 4 studies – consistent results
  - all found at least 50% increase in number of rapid response or ICU liaison team calls
  - 3 studies found a 6-33% decrease in number of code blue calls

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Results: Key Question 2B

What is the impact of EWS on resource utilization?

Nursing:

- Not well studied
- 3 studies reported on accuracy and compliance of scoring
  - Compliance as low as 53% in one study (1 study)
  - Accuracy as high as 81-100% with use of electronic calculations (1 study)
  - Most inconsistently recorded elements: Urinary output, LOC (1 study)
  - Most errors: Respiratory rate (1 study)
- Observations and clinical attention by nursing
  - Increased with greatest attention for EWS scores > 5 (1 study)
  - Frequency of observations per nursing shift increased during day but not night shifts (1 study)

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Results: Key Question 2B

What is the impact of EWS on resource utilization?

- Insufficient evidence
- Suggest that use of staffing may increase while the length of hospital or ICU stay remains uncertain

Limitations of the evidence

- **Methodological concerns**
  - Historical controls
    - Unknown, unmeasured confounding factors
    - Effects of time
  - None adjusted for pre-intervention trends in mortality rate nor accounted for other secular changes in care
  - None compared the rate of change pre-intervention (slope of the outcome) to the rate of change following implementation

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Summary of the evidence: Predictive Value

Outcome	N studies	Findings	Comments
Death within 48 hours	4 observational studies	Positive (AUROC 0.88 - 0.93)	4 models ranging from 4-7 items Strong predictive value Risk of differential exposure assessment due to case-control design (frequency of vital sign measurements may be different) and risk of over-fitting data due to derivation vs validation studies
Cardiac arrest within 48 hours	4 observational studies	Positive (AUROC 0.77 – 0.86)	As above

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Summary of the evidence: Health Outcomes

Outcome	N studies (combined sample size)	Findings	Comments
Mortality	6 observational studies	Mixed results	Trend toward decrease mortality Insufficient evidence due to methodological limitations
Cardiac Arrest	3 observational studies	Mixed results	Insufficient evidence

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Summary of the evidence: Resource use

Outcome	N studies	Findings	Comments
Length of hospital stay	3 observational studies	Mixed results	High risk of bias due to use of historical controls Insufficient evidence
ICU admissions and length of stay	4 observational studies	Mixed results	As above
Use of rapid response teams	4 observational studies	50% increase in calls; 6-33% decrease in code blue	Suggests the use of staffing increases High risk of bias due to use of historical controls
Nursing	3 studies	Compliance may be limited Accuracy may improve with electronic calculators	As above

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Future Research Suggestions

- RCTs
- Rigorous adherence to methodological standards for observational studies
- Clinically meaningful outcome measures
- Standardization of cut-offs to trigger a response
- Standardization of responses
- Prospectively track use of resources

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Questions?

If you have further questions, feel free to contact:

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The full report and cyber seminar presentation is available on the ESP website:

http://www.hsrd.research.va.gov/publications/esp/

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Panel Discussion