WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care

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EIT-026A

"In hospital staff (P), does use of any specific educational strategies (I) compared with no such strategies (C) improve outcomes such as earlier recognition and rescue of the deteriorating patient at risk for either cardiac or pulmonary arrest (O)?"

Is this question addressing an intervention/therapy, prognosis or diagnosis? Intervention
Is a proposed new topic or revision of existing worksheet: Revision; first draft submitted 10/08

Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? NO

Search strategy (including electronic databases searched).

Search for relevant research on the topic

Information sources

1. Literature search: US National Library of Medicine, Medline (Pub Med)
2. Files of articles on RRS/ monitoring / simulation / education and references therein
3. Looked up names of presenters at MET conference to see if they have done anything in this area.
4. Articles cited on the US Institute of Healthcare Improvement (IHI) website in its section on Rapid Response Teams
5. For years 2007, 2008 (only ones available) viewed abstracts presented at the International MET/ RRS meetings
6. Cochrane database

Medline (Pub Med) Search terms and results

No abstract / title/ MESH/ restrictions were placed on any of the search terms listed below. For all terms, the number indicated is the number yielded by the search strategy and screened (by title) for relevance to the question. The numbers listed in the 2000-2008 indicate results from our initial search; Sept 2008-8/2009 indicated additional titles searched for this revision. We did not use any language, age, gender, nationality, or time-based filtering, however, nearly all pertinent articles seemed to be written in English. I read over all titles yielded by each group of search terms, and read abstracts of studies that addressed any of the key aspects of the question:

(I) an educational intervention related to identification of patients likely to deteriorate
(O) improvement in survival or cardiac arrest rates due to any change in practice either with or without a related educational component

Most articles meeting these criteria fell into the following two categories:

(1) Articles describing implementation of a MET or RRT that had some staff introduction element that could qualify as "education," but no control group other than historical pre-intervention data.
(2) Opinion pieces, descriptive studies, reviews, and how-to descriptions of establishing a MET. Some of these articles were read if they were believed to contain some thoughts pertinent to the education or outcomes, or if there was a reasonable likelihood that they would reference potentially useful articles.

A few exceptions were found, in which the article actually attempted to link education to clinical outcome.

Inclusion and exclusion criteria
Articles were not considered further if they lacked any relevance to the intervention and outcome descriptions sought, if they were presented only in abstract form, or pertained to a pre-hospital population. Searches were restricted to publications from 2000 and later due to the relative underdevelopment of "failure to rescue," "medical emergency team," and "ICU outreach" concepts prior to that time. Inspection of reference lists from all later articles suggests that the assumptions underlying our beyond year 2000 "time restriction" were valid.

Articles **Text terms searched:**	*Date Ranges* *in search*	*2000-2008* Titles reviewed	*Sep-08- to 4/ 2009* *Additional titles reviewed*	*4/2009 – 8/2009* *New titles reviewed*
early rescue cardiopulmonary arrest		30	3	4
education early rescue		30	1	4
education rapid response system		87	4	9
education patient deterioration *[n=600; reviewed subcategories below]*				
+ respiratory		24	3	9 (1)
+ cardiac		72	8	12
education clinical deterioration prevention		58		5
education patient deterioration prevention		not done	10	5
education clinical deterioration rescue		0	0	0
deteriorated patient prevention		125	24	16
deterioration patient prevention		not done	108	99 (4)
medical emergency team education		685	38	60 (5)
rapid response system education		87	10	9 (1)
rapid response team education		41	12	12 (1)
cardiac arrest prevention education		208	23	14 (1)
failure to rescue education		36	6	8
education outcome cardiac arrest		267	21	27 (1*)
education outcome respiratory arrest		86	22	6
education outcome failure to rescue		11	3	0
outcome early rescue arrest		16	1	3
patient simulation deterioration		21	3	7 (1)
patient simulation rapid		not done	12	11
patient simulation rescue		10	0	1
education outcomes cardiac arrest		140	25	12 (1)
education outcomes respiratory		44	35	1

arrest				
problem based learning cardiac arrest		8	0	1
problem based learning respiratory arrest		2	0	0
	Total			
Titles reviewed	2773	**2088**	**372**	**313**
Potentially relevant studies, abstracts or texts read as appropriate	84	**50**	**19**	**15**
Directly useful studies	35	**24**	**5**	**4**

Summary of evidence

Evidence Supporting Clinical Question

Good				Sebat 2005& 2007, E^{1},^{2,3}	Bellomo 2004,E^{5} E^{6} Bellomo 2003, $E^{2,}$ E^{6} Buist 2002, $E^{2,}$ E^{3}, DeVita 2004, $E^{2,}$ $E^{3,}$ E^{6} Steadman 2006 E^{6} *Tibbals 2005 (ped),* $E^{1,3}$ Moldenhauer 2009 E^{1}, E^{6}
Fair			Spearpoint 2009 C, E^{1}. E^{2}, E^{3}		Dacey 2007, E^{2} ,E^{3}, E^{6} Bristow 2000, E^{4} Wayne 2008 E^{6} *Sharek 2007, $E^{2,}$ E^{3}*
Poor				Offner 2007, $E^{1,}$ E^{3} Foraida 2003; E^{1}, E^{6}	*Brilli 2007,* $E^{3,}$ E^{5} King 2006, E^{6} Johnson 2009, E^{6} Tolchin 2007, E^{2}
	1	**2**	**3**	**4**	**5**
Level of evidence					

A = Return of spontaneous circulation C = Survival to hospital discharge
B = Survival of event D = Intact neurological survival

E^{1} = Earlier recognition E^{2} = Reduction of deaths E^{3} = Reduction in arrests
E^{4} = Reduction in unplanned ICU admission, E^{5} = Decrease in code rate, E^{6} = Other
Italics = Pediatric studies

Evidence Neutral to Clinical question

Good				Jones 2006, E1	Subbe 2003 Smith 2002, E^6 Smith 2004, E^6 Featherstone 2005 E^6
Fair			Fuhrmann 2009 E^1 E^2		Johnson 2009, E^6 Wynn 2009, E^6
Poor					Lee 1995, E^6 Tolchin 2007 E^2 Mailey 2006, E^6
	1	**2**	**3**	**4**	**5**
Level of evidence					

A = Return of spontaneous circulation C = Survival to hospital discharge
B = Survival of event D = Intact neurological survival

E^1 = Earlier recognition E^2 = Reduction of deaths E^3 = Reduction in arrests
E^4 = Reduction in unplanned ICU admission, E^5 = Decrease in code rate, E^6 = Other
Italics = Pediatric studies

Evidence Opposing Clinical Question

Good					
Fair					
Poor					Kenward 2004, E^3
	1	**2**	**3**	**4**	**5**
Level of evidence					

A = Return of spontaneous circulation C = Survival to hospital discharge
B = Survival of event D = Intact neurological survival

E^1 = Earlier recognition E^2 = Reduction of deaths E^3 = Reduction in arrests
E^4 = Reduction in unplanned ICU admission, E^5 = Decrease in code rate, E^6 = Other
Italics = Pediatric studies

Concept of question:

This seems to address a very broad target population consisting of RNs, MDs, and other types of therapists with patient contact. I think we are being asked: "for any potential target of an educational intervention, which interventions have had positive impacts on what would be considered beneficial patient outcomes (early recognition and rescue of at risk patients)."

Problems and general thoughts related to the question:

1. Question assumes there may be a number of strategies that can have the benefits listed above.

2. Question asks us to compare intervention vs no intervention (where the only variable changed would be the presence of an identifiable educational strategy).

3. Education functions along the assumption that "knowledge is good," and does little to question the clinical outcome value produced by such effort.

4. Education has generally stated goals of improving knowledge, skills and attitudes. Thus most research on education focuses on these end points rather than any clinical benefit associated with the educational effort. For example see Gary Smith's work (Smith 2004, 117, Featherstone 2005, 329). It is easy to show that some form of teaching improves knowledge (tests), and skills (time of completion, fewer errors) and attitudes (questionnaires), but none of these has a really strong link to patient benefit. Questionnaires documenting trainees' self-reported levels of competence, for example, often produce over-estimates of true skill.

5. Educational strategy in question EIT-026A seems to mean something traditional, where *instructors are present with trainees*. There are other entities, such as MET programs, cardiac arrest teams, and safety initiatives, that when implemented, *have the eventual result of providing education.* Comparing these with "no such strategies" is fairly easy, however, it is never clear what aspect of the program produced the change in behavior and change in outcome.

6. Finally, the outcome "earlier recognition" is difficult to define, and is ultimately subjective. For example, a study of an educational strategy that prompted 30 nurses to state they called for help on a patient "earlier than they would have before the course" would qualify as a positive educational outcome--even in the absence of some means to establish "earlier recognition."

REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

DISCUSSION

The studies uncovered by our search strategy fell into a few broad categories that can be summarized as follows:

1) Studies on the MET / RRS intervention that did speak to outcomes, but had no direct relationship to a specific educational strategy other than informing staff members about the MET. It could be implied by the success of some of these efforts that earlier recognition of deterioration occurred.

2) Studies that discussed educational programs relevant to identification of patients at risk, but that used internal metrics (surveys, tests demonstrating change in knowledge skills and attitudes) rather than clinical outcome metrics such as calling the MET, or changes in arrest or mortality rates.

3) Studies that attempted to link the educational intervention to the use of the emergency services and linking this change to changes in clinical outcomes.

In our prior submissions, we commented extensively on the first two categories listed above, as no high quality studies in the real category of interest (# 3) had been published. As all of the category #1 and 2 studies represent class 5 evidence relative to the research question, and because worksheet EIT-024 is

considering the efficacy of the MET/ RRS intervention, comments on these studies have been removed from this discussion and placed in an appendix below, (and might be best to eliminate altogether). Other studies on educational efforts related to at risk patients, but that lacked a linkage to clinical outcomes are also placed in the appendix.

Linkage between education programs and clinical outcomes.

The most promising group of intervention are the Immediate life support (ILS) and ALERT courses introduced and implemented on a widespread basis in the UK . Soar 2003, 21, and Smith 2004, 61 (respectively) provide the initial descriptions of the content and evaluation of the course. Later, Spearpoint 2009, 638, provides an evaluation of the ILS course, where call types and volumes and cardiac arrest outcomes are tracked over six years in two hospitals. While there was no change in the number of arrest + pre-arrest calls over the study period, the proportion of calls for pre-arrests rose progressively from 15% to 58% over the study period ($p< 0.0001$), true arrests declined ($p< 0.0001$), survival to discharge after cardiac arrest improved from 15% to 21% ($p=0.0002$), and the survival to discharge following both classes of emergency calls (combined) improved from 28% (at the mid point of the study when data was first gathered) to 39% at the conclusion of the study period. The authors also show that the number pre-arrest events per month tracked the increase in staff training in ILS that rose from 0 to over 75% of the staff at the conclusion of the study. Particular strengths of this work include a multi-center design, long duration, strict definitions of "arrests" and "pre arrests," careful tracking of calls made for these states, and use of a standardized curriculum. The educational intervention was not coupled to the rollout of a MET or CCOT (rather it encouraged expanded use of existing resuscitation teams), so its success can not be attributed to the new team, but rather to the educational program, itself. Weaknesses of the study are its vague description of educational target and reference population, inability to control for confounders including other quality improvements, and the introduction of the 2005 resuscitation guidelines during the study period of 2002-2007. As an ecologic study of outcomes, we would rate the evidence provided by this study as level 2C.

The Fuhrmann study from 2009, 1357 is a prospective before-and-after study with several end-points: detection of deteriorating patients and mortality. The educational intervention is well described; a multi-professional 1-day simulation-based course aimed at detection and treatment of potentially critically ill patients. Contrary to other reported simulation based interventions the outcome is clinical. No MET was available or introduced during the study period. No difference was found in the staff's detection of deteriorating patients. Study personnel found 129/690 (patients with abnormal vitals/ total population measured) before the intervention and 155/873 after the intervention. Staff was aware of the patients with adverse signs in less than half of the cases both before and after intervention. Also, mortality (30-days and 180-days) did not differ in the two periods. Reasons given in the paper for this lack of difference were incomplete training of nurses (67%) and physicians (49%), and high nurse turnover (20%) during the study period. The initial target was to have 75% of staff trained, but only 50% was accomplished. The study was weakened further by a lack of control group and lack of documentation of patient case mix before and after the study. The study is considered level 3E.

Jones 2006, 231 reports the impact of a multifaceted educational program including orientation lectures to physicians, presentations to nursing staff, department-level presentations, and regular audits over a four-year period. Splitting call volume into medical and surgical wards, the authors found an increase in surgical MET calls of 1.13 calls/ 1000 admissions/ month, versus no effect (0.23/ 1000/ month) in medical patients. The study highlights that differences in behavior regarding willingness to call the MET may exist between different departments or treating specialties. The study supports the experience and intuition of many, that maintaining successful MET/ RRS programs require continual feedback to front-level providers; however, on quantitative grounds, we found the quality of the study to be poor. Statistical comparisons were made only between medical and surgical services, with no attempt to analyze the significance of the individual trends. The educational effort may be hard to reproduce in other institutions, as numbers of participants, frequency of encounters, and content are given no mention. Probably grade 4, given the qualities noted, and the conflicting set of results.

Foraida 2003, 18 reports the impact of a four interventions designed to increase utilization of the MET service at an urban hospital in the USA. The combination of provider feedback for cases that should have been MET activations as well as disseminating calling criteria reduced non-MET emergency pages and increased MET calls by 19.2 per month (P<0.0001). Strengths of the study show that the main intervention that led to sustained use of the MET for emergencies was the posting of calling criteria. During the study period, there was a significant decline in cardiac arrests (4.3 to 2.2 per 1000 admissions (p<0.001). This is the only study to even partially evaluate the need for calling criteria as part of MET/ RRS operation, and is able to relate their interventions to a control period. Weaknesses of the study as an purely educational effort are many, and include the overlap of multiple interventions, the lack of normalization of MET calls to hospital occupancy or bed turnover, and that the arrest rate decline was reported as "personal communication" (which was subsequently published by the group) and not an end point of the study with methodology described. Evidence as an educational intervention is probably level 4-5.

Acknowledgements:

Citation list with annotations:

1. Bellomo, R., et al., Prospective controlled trial of effect of medical emergency team on postoperative morbidity and mortality rates. Crit Care Med, 2004. 32(4): p. 916-21.

Main topic of paper: MET, Australia
Intervention: Lectures and tutorials given to nursing staff and paramedical personnel
LOE: 5; historic controls
Outcome: Sig. decrease in unplanned IUC admits, stroke, renal failure, sever sepsis and respiratory failure…no significant decr. in deaths.

2. Bellomo, R., et al., A prospective before-and-after trial of a medical emergency team. Med J Aust, 2003. 179(6): p. 283-7.

LOE: 5 (but prospective results before and after intervention).
Outcome: serious adverse events, mortality
No real discussio of education strategy, except for staff introduction to the MET

3. Brilli, R.J., et al., Implementation of a medical emergency team in a large pediatric teaching hospital prevents respiratory and cardiopulmonary arrests outside the intensive care unit. Pediatr Crit Care Med, 2007. 8(3): p. 236-46; quiz 247.

Intervention: 4 months of presentation to RNs MDs, faculty meetings, resident conferences
LOE: 5, historical control
Outcome: Sig decr in code rate, decrease (but not significant) in mortality

4. Bristow, P.J., et al., Rates of in-hospital arrests, deaths and intensive care admissions: the effect of a medical emergency team. Med J Aust, 2000. 173(5): p. 236-40.

Main topic of paper: Compare ICU admissions, deaths and arrests in hospital with MET and compare to two control hospitals
Intervention: MET and edu. program describing function and role of MET to new staff.
"Hospital 1" compared with control Hospitals "2 &3" where there was a traditional cardiac arrest team
LOE:5 Hospitals not randomized, but did contain control groups; there was statistical adjustment for differences in case mix between the three hospitals.
Outcome: sig decr in ICU admissions in Hosp 1 versus controls, no signif. decrease in arrest and death rates after case mix adjustments were made. MET was obviously bundled with various introductions to the function of the MET, so hard to dissociate the contribution of this type of educational program. Results probably reflect greater credit on MET intervention than anything else.

5. Buist, M.D., et al., Effects of a medical emergency team on reduction of incidence of and mortality from unexpected cardiac arrests in hospital: preliminary study. Bmj, 2002. 324(7334): p. 387-90.

LOE: 5 (but prospective results before and after intervention).
Outcome: cardiac arrests, mortality after cardiac arrest
No real discussion of education strategy, except for staff introduction to the MET
6. Dacey, M.J., et al., The effect of a rapid response team on major clinical outcome measures in a community hospital. Crit Care Med, 2007. 35(9): p. 2076-82.

Main topic of paper: MET/ RRS
Intervention: Nursing education meetings with all ward staff
No real discussion of education strategy, except for staff introduction to the MET
LOE:5; historic control
Outcome: decrease in cardiac arrests, mortality, ICU length of stay
7. DeVita, M.A., et al., Use of medical emergency team responses to reduce hospital cardiopulmonary arrests. Qual Saf Health Care, 2004. 13(4): p. 251-4.

LOE: 5 (but prospective results before and after intervention).
Outcome: cardiac arrests, mortality after cardiac arrest, number of post-cardiac arrest bed-days
Educ strategy: No real discussion of education strategy, except for staff introduction to the MET
8. Featherstone, P., et al., Impact of a one-day inter-professional course (ALERT) on attitudes and confidence in managing critically ill adult patients. Resuscitation, 2005. 65(3): p. 329-36.

Anecdotal evidence suggests that anxiety and lack of confidence in managing acutely ill patients adversely affects performance. We evaluated the impact of attending an ALERT course on the confidence levels and attitudes of healthcare staff in relation to the recognition and management of acutely ill patients. A questionnaire, which examined knowledge, experience, confidence and teamwork, was distributed to participants prior to commencing an ALERT course. One hundred and thirty-one respondents agreed to participate in a follow-up questionnaire 6 weeks after completing the course. Respondents reported significantly more knowledge (pre 5.47+/-1.69, post 7.37+/-1.22; $p < 0.01$) in recognising a critically ill patient after attending an ALERT course. Mean scores for respondents' confidence in their ability to recognise a critically ill patient (pre 6.04; post 7.71; $t = 11.74$; $p < 0.01$), keep such a patient alive (pre 5.70; post 7.30; $t = 10.01$; $p < 0.01$) and remember all the life-saving measures (pre 5.60; post 7.32; $t = 11.71$; $p < 0.01$) were increased. Fewer respondents were very worried about being responsible for a critically ill patient (pre 13; post 2; $chi2 = 8.55$; $p < 0.003$). There was a significant increase in the number of respondents indicating that they would use a system of assessment for acute illness (pre 23; post 37; $chi2 = 4.25$; $p = 0.035$). More staff said that they would approach a registrar or a consultant for help ($chi2 = 3.29$, $n = 131$, $p < 0.05$; $chi2 = 7.51$, $n = 131$, $p < 0.01$). There was a significant improvement in attendees' confidence in working in an interdisciplinary team when caring for critically ill patients (pre 40.66; post 42.91; $t = 2.32$; $p = 0.05$). We conclude that attending an ALERT course has beneficial effects on the confidence levels and attitudes of healthcare staff in relation to the recognition and management of acutely ill patients.
Intervention: follow up on popular ALERT course offered in UK. Showed general efficacy of course relative to subjective measures of knowledge, attitude, and confidence. Not linked with any clinical outcomes. LOE: 5.
9. Ferrer, R., et al., Improvement in process of care and outcome after a multicenter severe sepsis educational program in Spain. Jama, 2008. 299(19): p. 2294-303.

Outcome: Hospital mortality, recognition and management (adherence to bundles) of septic shock, but multiple groups, emergency room, wards, ICU. Mortality decreased, discharge to home or rehabilitation increased. Event frequencies returned to baseline after 1 year. Educ strategy: intensive education of many groups both doctors and nurses in many hospitals, establishment of local champions, training with regards to case-type definitions, early recognition and treatment of sepsis.
10. Foraida, M.I., et al., Improving the utilization of medical crisis teams (Condition C) at an urban tertiary care hospital. J Crit Care, 2003. 18(2): p. 87-94.

Main topic of paper: Improving the frequency of MET calls. The idea here is that a closely timed batch of "stat pages" represents a medical emergency that should probably be attended to by the MET.
Intervention: Review of serial stat pages, feedback to caregivers, creation and dissemination of objective criteria for MET activation. Data makes reasonable suggestion that the discussion of and posting of “calling criteria” proved to be the key intervention that led to greater use of condition C (or MET) calling system. This study is of fairly low quality as far as methodology that can support the claim that calls were actually increased by the “educational intervention,” yet it is the ONLY study to date that reports the existence of a MET/RRS prior to posting of calling criteria, and does make a strog suggestion that this component does change behavior.
LOE: 4; E1 historical control
Outcome: Increased call volume by 19 calls per month; reduced serial stat pages by about 5 per month.
11. Fuhrmann, L., et al., The effect of multi-professional education on the recognition and outcome of patients at risk on general wards. Resuscitation, 2009.

Intervention: Single day, simulation based course based on early identification of at-risk patients, with investigators obtaining vitals signs of ward patients and interviewing nurses regarding responses, both before and after the educational program. There was no change in the presence of at risk patients or the nurse response to these patients as a result of the study. LOE=3, arguing against the intervention, although staff receiving the training may not have been sufficiently high to have an impact on patient outcomes.

12. Hillman, K., et al., Introduction of the medical emergency team (MET) system: a cluster-randomised controlled trial. Lancet, 2005. 365(9477): p. 2091-7.

Main topic of paper: Efficacy of MET system
Intervention: advertising MET program via meetings with nurses and doctors
LOE: 5; cluster randomized
Outcome: No change in cardiac arrest or mortality rate. Evidence neutral (with several qualifiers) relative to efficacy of MET system, and no clear evidence relating to any educational programs.

13. Johnson, A.L., Creative education for rapid response team implementation. J Contin Educ Nurs, 2009. 40(1): p. 38-42.

The Institute for Healthcare Improvement advocates implementation of rapid response teams (RRTs) to bring experts to the bedside to assist with patient assessment and treatment. Due to shrinking budgets and limited resources, initiating new programs and policies can be challenging in the health care environment. This article highlights a creative approach that a community hospital used to provide staff education during the RRT implementation process. This education plan includes a review of learning considerations, creation of a video, and other strategies that could be used by staff development educators for a variety of other topics.
0022-0124 (Print)
Journal Article

14. Jones, D., et al., Effect of an education programme on the utilization of a medical emergency team in a teaching hospital. Intern Med J, 2006. 36(4): p. 231-6.

LOE: 3 (but prospective results before and after intervention).
Outcome: activation of MET (finding the crit ill patients)
Educ strat: lectures, presentations, tutorials. Extensive feed-back and re-inforcement. Intervention did lead to increased call volumes on surgical wards (E1), and no impact on call volumes on a medical ward. This suggests that the impact of education was likely neutral, and only successful when there is an optimal interaction with other cultural and patient-related factors.

15. Kenward, G., et al., Evaluation of a medical emergency team one year after implementation. Resuscitation, 2004. 61(3): p. 257-63.

Main topic of paper: MET--
Intervention:no edu program reported
LOE: 5; historical control
Outcome: did not find any change in arrest rate. No real discussion of education strategy, except for staff introduction to the MET

16. King, E., R. Horvath, and D.J. Shulkin, Establishing a rapid response team (RRT) in an academic hospital: one year's experience. J Hosp Med, 2006. 1(5): p. 296-305.

Intervention: Educational inservices for MDs and RNs, laminated cards for all hospital staff, posters on wards
LOE: 5
Outcome: Subjective opinion that the RRS benefited patients. No real discussion of education strategy, except for staff introduction to the MET

17. Lee, A., et al., The Medical Emergency Team. Anaesth Intensive Care, 1995. 23(2): p. 183-6.

Intervention:Implementation of RRS, NO educational program mentioned
LOE: 5
Outcome: Only reported call volume; no mention of survival, arrests, etc.

18. Mailey, J., et al., Reducing hospital standardized mortality rate with early interventions. J Trauma Nurs, 2006. 13(4): p. 178-82.

Main topic of paper: RRS implementation
Intervention: meetings to present calling criteria. Program piloted on certain floors; this experience was used to inform other floors that implemented program later.
LOE: 5, historic controls
Outcome: Trend suggests a decrease in respiratory problems

19. Moldenhauer, K., et al., Clinical triggers: an alternative to a rapid response team. Jt Comm J Qual Patient Saf, 2009. 35(3): p. 164-74.

LOE =5 . Threre was no educatinal program independent of institution of mandates for time-sensitive evaluation.
20. Offner, P.J., J. Heit, and R. Roberts, Implementation of a rapid response team decreases cardiac arrest outside of the intensive care unit. J Trauma, 2007. 62(5): p. 1223-7; discussion 1227-8.

Main topic of paper: RRT
Intervention: formal educational program given to hospital staff consisting of discussions and presentations
LOE:4,, (E1, E3) historic controls
Outcome: Decrease in cardiac arrests associated with presence of team and calling for the team
21. Sebat, F., et al., A multidisciplinary community hospital program for early and rapid resuscitation of shock in nontrauma patients. Chest, 2005. 127(5): p. 1729-43.

LOE: 4 , C, E1, E3(but prospective results before and after intervention).
Outcome: recognition and management of non-traumatic shock, but multiple groups, emergency room, ICU. mortality decreased, discharge to home or rehabilitation increased.
Educ strategy: intensive education of many groups. presentations, posters, activation of shock-team
22. Sebat, F., et al., Effect of a rapid response system for patients in shock on time to treatment and mortality during 5 years. Crit Care Med, 2007. 35(11): p. 2568-75.

Main topic of paper: Shock Team--essentaially a RRS with well circumscribed criteria for shock
Intervention: This had the most comprehensive educational program of all the papers I have read…shock manual distributed, slide presentation (given to over 500), [posters, mock alerts, feedback to ward staff regarding calls and patient outcomes.
LOE:4; historic control
Outcome: Decrease in mortality. E1, E3
23. Sharek, P.J., et al., Effect of a rapid response team on hospital-wide mortality and code rates outside the ICU in a Children's Hospital. Jama, 2007. 298(19): p. 2267-74.

Main topic of paper; RRT, peds
Intervention: Posters, wallet cards
LOE: 5, historical control using time series analysis.
Outcome: Signif. decr in codes and mort rate
No real discussion of education strategy, except for staff introduction to the MET
24. Smith, G.B., V.M. Osgood, and S. Crane, ALERT--a multiprofessional training course in the care of the acutely ill adult patient. Resuscitation, 2002. 52(3): p. 281-6.

LOE: 5. Description of the educational strategy: scenarios, reflection, feed-back. Skills and attitudes, and communication.
25. Smith, G.B. and N. Poplett, Impact of attending a 1-day multi-professional course (ALERT) on the knowledge of acute care in trainee doctors. Resuscitation, 2004. 61(2): p. 117-22.

LOE: 5 (no control group) questionnaire assessing knowledge of care for acutely ill patients not care. 1-day course (ALERT) is educat strategy.
Outcome: knowledge of care for acutely ill patients
26. Soar, J., et al., The immediate life support course. Resuscitation, 2003. 57(1): p. 21-6.

Intervention: Development of skills course and pressentation of a standardized curriculum. No clinical impacts assessed. LOE: 5.
27. Spearpoint, K.G., P.C. Gruber, and S.J. Brett, Impact of the Immediate Life Support course on the incidence and outcome of in-hospital cardiac arrest calls: an observational study over 6 years. Resuscitation, 2009. 80(6): p. 638-43.

Intervention: Teaching and slight modification of ILS course described by Subbe 2003, 797. No MET intervention during study period; use of code team for non-cardiac arrests, mortality and discharges followed as outcomes. Intervention increased intervention by code team for non arrest situations throughout time periods studied. Cardiac arrest deaths and survival to discharge improved during the study period. Good quality study for retrospective design with minimal intereference of uncontrolled covariants; LOE 3 supporting intervention; (E1, E2, E3).
28. Steadman, R.H., et al., Simulation-based training is superior to problem-based learning for the acquisition of critical assessment and management skills. Crit Care Med, 2006. 34(1): p. 151-7.

Relative to pure educational strategy, LOE: 1 RCT with medical students in simulator setting versus problem based learning.
Relative to patient outcomes, LOE: 5.
Outcome: critical assessment and management of critically ill patients (in simulator setting) Educ strategy: one-week simulation based course

29. Subbe, C.P., et al., Effect of introducing the Modified Early Warning score on clinical outcomes, cardio-pulmonary arrests and intensive care utilisation in acute medical admissions. Anaesthesia, 2003. 58(8): p. 797-802.

Main topic of paper: Use of MEWS to detect at risk patients
Intervention: Implementation of MEWS to prompt calls to CCOT
LOE: 5; historically controlled prospective study
Outcome: No change in mortality as a result of implementing the MEWS

30. Tibballs, J., et al., Reduction of paediatric in-patient cardiac arrest and death with a medical emergency team: preliminary results. Arch Dis Child, 2005. 90(11): p. 1148-52.

Main topic of paper: MET, Pediatric
Intervention: posters, workshop, increased PALS enrollment, case presentations
LOE:5, historical controls. Hard to dissociate MET program from education program.
Outcome: decr cardiac arrest rate (E1, E3)

31. Tolchin, S., et al., Eliminating preventable death at Ascension Health. Jt Comm J Qual Patient Saf, 2007. 33(3): p. 145-54.

Main topic of paper: ICU based quality improvements were made in a hospital, including RRS.
Intervention: RRS educational component not specified
LOE: 5, Historic controls
Outcome: Decrease in mortality of 20%

32. Wayne, D.B., et al., Simulation-based education improves quality of care during cardiac arrest team responses at an academic teaching hospital: a case-control study. Chest, 2008. 133(1): p. 56-61.

LOE: 5, case control. One group simulator trained the other traditionally trained.
Outcome: adherence to AHA guidelines (in clinical practice), increase in quality of care
Educ strategy: 10-hour- simulation based course

33. Wynn, J.D., M.K. Engelke, and M. Swanson, The front line of patient safety: staff nurses and rapid response team calls. Qual Manag Health Care, 2009. 18(1): p. 40-7.

Investigators found that Nurses with higher levels of pre-practice education and experience were 5 and 4 times more likely (respectively) to summon help independently. LOE=5.

Appendix

I. Comments on conclusions that can be made from MET intervention studies:

A) Multi-center studies utilizing intervention and control hospitals. The most prominent study in this area was a cluster-randomized trial of 11 control and 12 study hospitals, where the intervention was a four month educational campaign followed by the operation of a MET for the following six months (Hillman 2005, 365). Although the statistical and methodological issues may have left the study underpowered to truly rule in or out an intervention effect, this level 1 study has been used as evidence against the efficacy of MET/ RRS. Prior to that Bristow 2000, 173, used a case/ control design and found a decrease in ICU admissions in the target hospital, but no significant difference in morality or arrest rates after case mix adjustments were made.

B) Historically controlled studies of Medical Emergency or Rapid response systems (MET/RRS) in which staff education was one of several introduced elements. Supportive studies were those that had some positive patient outcome as well as mention of an educational strategy. Neutral studies were those that failed to mention an educational component, despite positive patient outcomes; studies lacking statistical evidence of patient benefit were considered to be “opposing” studies. Accordingly, the work of Bellomo 2003, 179 is notable for a reduction in whole hospital mortality attributable to a MET, and later, a reduction in organ failures in Surgical patients (Bellomo 2004, 916). Morality reductions were also documented by Dacey 2007, 2076 and Sebat (2007 35, and 2005127). Some reviews of MET/RRS have neglected the work of Sebat because his work targeted the recognition of shock in emergency room patients, while most MET/ RRTs were developed with deteriorating ward patients in mind. Nonetheless, with probably the most comprehensive educational intervention, his program reduced mortality and enabled quicker achievement of favorable “process” milestones for shock management such as CVP line placement, antibiotic and fluid administration, and ICU admission. A number of authors have found decreases in cardiac arrests following MET/RRS implementation including Buist 2002 324, DeVita 2004 13, and Offner 2007 1223.

Fewer pediatric studies have been published, but all have reported a parallel set of positive outcomes including reduction in cardiac arrest rate (Brilli 2007, 8 and Tibbals 2005, 90), and reduction in both mortality and cardiac arrests (Sharek 2007, 289). The latter study stands out from most adult studies by reducing arrests within two months of RRS implementation, and for careful statistical analysis that included adjustment for patient acuity, and evaluation of seasonal effects and other secular trends by time series analysis.

Neutral and less persuasive studies are listed on the grid, and include those by Mailey 2006, 178 who found a decrease in progression of respiratory problems, Lee 1995, 23, who reported an increase in call volume, but no positive patient outcomes, and no stated educational intervention in this before/ after MET study, and Tolchin (2007 33), who showed a 20% decrease in mortality over historic controls as part of a large bundle of interventions that included a RRS and a number of ICU-based quality improvement measures, but no description of educational efforts. A recent study by Moldenhauer 2009, 164 and colleagues describe a set of policies in which nurses are required to page interns upon discovery of a defined set of “clinical triggers.” The policy mandates that senior help be called if the initial response is slow; the study did not mention an educational strategy, yet reported a sizable volume of calls based on this policy.

Chan and Rothschild published studies showing no impact on hospital outcomes. Rothschild 2008, 417 described a findings from a RRS which had both historical and contemporaneous controls, the latter being medical specialty wards that would not receive the MET intervention, (and interestingly, a group that had higher co morbidity scores). The team consisted of the regular covering intern as well as a critical care nurse and respiratory therapist from a float pool. Education to any of the responders as well as to ward staff making the calls was by the authors’ admission, very minimal. The intervention failed to

make any improvement in cardiac arrest rate, mortality, ICU admission, or length of stay. Similar results were found for a RRS descried by Chan 2008, 2506. The latter study engaged in careful analysis that took into account seasonal trends and changes in outcomes attributable to other quality improvement activities. They also included arrests occurring in the ICU as part of their analysis, unlike many other studies, and found that the overall arrest rate and mortality rates were not affected by institution of the RRS.

II. Comments on conclusions that can be made on educational strategies that address patients at risk, but lack clinical measurements of efficacy in patients.

Soar 2003, 21 describes the Immediate life support course, whose goal is to provide 'front line providers' with the skills to recognize patients at risk for deterioration, and to additionally provide basic life support (CPR and AED) skills to the same group of providers. The work of Spearpoint 2009, 638 to link the use of this class to clinician behavior and outcomes is discussed above. Smith in the UK has developed a program specifically aimed at improving new nurse and physician skills in evaluation and early treatment of unstable patients (Smith 2002, 281 and 2004, 61 and Featherstone 2005). The educational intervention includes use of a standard curriculum including types of patients discussed, relevance of these patient problems to ward deterioration, and tools including group discussions and role playing. A standard evaluation system is introduced and practiced. The impact of the course on changes in call volume for unstable patients has not been evaluated, and may be impossible to evaluate based on context variables. Nonetheless, follow up questionnaires have demonstrated significant improvements in knowledge base, confidence, and willingness to call for help. Likewise, McGaughey 2009, 11 has introduced modules on recognizing unstable patients in the advanced year of nursing education. While the potential for both of these efforts is huge, current evidence grading methods had us rate these papers as being neutral to the question, with level 5 evidence overall.

An article by Amy Johnson 2009,38 provides the most detailed description of an educational effort and information distribution system prior to rollout of a RRS. The RRS administrators produced an informational video, distributed DVDs to all nursing staff, and used a purple color theme related to the RRS "code purple" designation. While there was no comparison group, their intervention was supported by cited studies showing an increased retention of visually presented information. A very non-rigorous analysis of cardiac arrest rate showed a 50% drop related to the 86 calls during the first year of operation.

III. Other factors associated with increased recognition of patients at risk, or increased call volume that are not related to an identifiable education program

A) Years of education.

Wynn (2009, 40) conducted a descriptive cross-sectional survey study to explore factors underlying nurses' willingness to call the RRT for at-risk patients. Using previously validated survey/ scoring instruments (and with a 70% response rate) they found that Nurses with higher levels of pre-practice education (BSN vs. ADN) and experience (> 3 yrs vs. < 3 yrs) were 5 and 4 times more likely (respectively) to summon help independently. While this does not address educational strategy per se, it does balance out studies where increased call volume may be attributable to a policy, with the observation that experience, intuition and critical thinking skills play an important role in recognition of patient deterioration.

B) Clinical screening and "force functions"

The authors recognize that there is significant interest in using single MET criteria or manually generated compilations to identify deteriorating patients. Automation has also been applied to continuously generated data streams (as may be found in a step down or intermediate ICU). All of these systems are in the development and validation phase where sensitivity, specificity and predictive values for mortality and other adverse events are calculated for different numerical score cutoffs. Subbe 2003, 797 used a multiparameter early warning system to summon a critical care outreach team. This

historically controlled study did not note changes in call frequency or volumes, and found no impact on mortality or arrests. If more rigorously studied, this may prove to be a promising intervention. We will continue to monitor this field for further developments.