5 Appendices

5.1 Appendix 1 – The Scope

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE

SHORT CLINICAL GUIDELINE

SCOPE

1 Title

Recognition of and response to acute illness in adults in hospital

1.1 Short title

Acutely ill patients in hospital

2 Background

a) The Department of Health has asked the National Institute for Health and Clinical Excellence ('NICE' or 'the Institute') to 'prepare guidance on the care of acutely ill adults in hospital' for use in the NHS in England and Wales.

3 Clinical need for the guideline

a) There has been increasing recognition that the care provided to patients in hospital who deteriorate clinically, or show signs that they may deteriorate unexpectedly, has a marked impact on patient mortality, morbidity and length of stay both in the hospital overall and in a critical care area should they be admitted to critical care.

b) Clinical deterioration can occur at any stage of a patient's illness, although there will be certain periods during which a patient is more vulnerable, such as at the onset of illness, during surgical or

medical intervention and during recovery from critical illness. Patients on general adult wards who are at risk of deteriorating may be identified before a serious adverse event by changes in physiological observations recorded by clinical staff.

c) The interpretation of these changes, and timely institution of appropriate clinical management once physiological deterioration is identified, is of crucial importance if the likelihood of serious adverse events including cardiac arrest and death is to be minimised. Care strategies following a period of critical illness are also likely to have a significant impact on patient outcomes.

d) A recent report from the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) ('An Acute Problem', NCEPOD 2005)[1] identified delayed recognition and referral as prime causes of the substandard care of the acutely unwell in hospital. The report found that on a number of occasions this was aggravated by poor communication between the acute medical, surgical and critical care medical teams. It also identified examples in which there was a lack of awareness by medical consultants of their patients' deteriorating health and their subsequent admission to critical care. Admission to an intensive care unit (ICU) was thought to have been avoidable in 21% of cases, and the authors felt that sub-optimal care contributed to about a third of the deaths that occurred.

4 The guideline

4.1 Population

4.1.1 Groups that will be covered

All adult patients in hospital, including patients in the Emergency Department and those in transition.

[1] Cullinane M, Findlay G, Hargraves C et al. (2005) *An Acute Problem? A report of the National Confidential Enquiry into Patient Outcomes and Death*. London: National Confidential Enquiry into Patient Outcome and Death. Available from: www.ncepod.org.uk/2005.htm

4.1.2 Groups that will not be covered

a) Children

b) Dying patients who are receiving palliative care.

c) Patients in Critical Care areas who are directly under the care of critical care consultants.

4.2 Healthcare setting

All adult acute hospital settings.

4.3 Clinical management and service delivery strategies (including key interventions)

a) Identification of patients who are at risk of clinical deterioration or whose clinical condition is deteriorating. This will include assessment of:

- scoring tools that record physiological parameters and neurological state
- the level of monitoring needed and the recording and interpretation of the data obtained.

b) Response strategies to manage patients who are at risk of clinical deterioration or whose clinical condition is deteriorating , including:

- the timing of response and patient management
- the communication of monitoring results to relevant healthcare professionals, including the interface between critical care and acute specialties.

c) Discharge of patients from Critical Care areas. This will include:

- monitoring requirements.
- timing of transfer.

4.4 Key outcome measures

Key outcomes that will be considered when reviewing the evidence include:

- hospital mortality (survival to discharge), including number of unexpected deaths
- adverse events (for example, cardiac and respiratory arrest and organ failure)
- length of stay on acute wards and in Critical Care Areas
- number of avoidable Critical Care admissions
- number of readmissions into Critical Care Areas
- functional status, health-related quality of life and satisfaction with care.

4.5 Economic aspects

The developers will take into account both clinical and cost effectiveness.

4.6 Status

4.6.1 Scope

This is the final scope.

4.7 Other relevant NICE guidance

4.7.1 Guidelines

Nutrition support in adults: oral nutrition support, enteral tube feeding and parenteral nutrition. *NICE clinical guideline* no. 32 (2006). Available from: http://www.nice.org.uk/page.aspx?o=cg032

4.7.2 Guideline

The development of the guideline recommendations will begin in December 2006.

5 Further information

Information on the guideline development process is provided in:

- ‘The guideline development process: an overview for stakeholders, the public and the NHS’
- ‘The guidelines manual’.

These booklets are available as PDF files from the NICE website (www.nice.org.uk/guidelinesmanual). Information on the progress of the guideline will also be available from the website.

The development group will work in accordance with the methods set out in the documents above. The process for the short clinical guidelines programme is in development and will be consulted upon.

5.2 Appendix 2 - Key Clinical Questions

The key clinical questions were used by the GDG to help focus discussions on the key aspects of the subject area and also to help develop the recommendations for this guideline. The following key clinical questions formed the basis of the recommendations discussed in chapter 2 of this guideline:

- Which physiological observations should be undertaken in acute hospital settings?
- Can physiological track & trigger systems correctly identify those patients whose clinical condition is deteriorating or who are at risk of deterioration?
- What is the role of specific physiological track & trigger systems in identifying patients whose clinical condition is deteriorating or who are at risk of deterioration?
- Physiological parameters to be used by track & trigger systems
- Does a specific response strategy – provision of critical care outreach service - improve outcomes for patients identified as having a deteriorating clinical condition?
- Does the timing of transfer of a patient from Critical Care Areas to general wards affect health outcomes?
- What elements of care on the general ward are viewed as important by patients following discharge?
- What interventions can be delivered to patients on general wards following discharge from Critical Care Areas to improve health outcomes?

5.3 Appendix 3 – Search Strategies

5.3.1 Scoping searches

Scoping searches were undertaken using the following websites and databases in September 2006. Browsing or simple search strategies were employed.

Guidance/guidelines	Systematic reviews/economic evaluations
Websites ▪ Department of Health ▪ National Institute for Health and Clinical Excellence (NICE) ▪ National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) ▪ National Library for Health (NLH) Guidelines Finder ▪ National Library for Health (NLH) Protocols and Care Pathways database ▪ National Library for Health (NLH) Specialist Libraries ▪ TRIP Database ▪ Scottish Intercollegiate Guidelines Network (SIGN) ▪ National Guideline Clearinghouse (USA) ▪ Guidelines International Network (GIN) ▪ New Zealand Guidelines Group ▪ National Health and Medical Research Council (Australia) ▪ CMA Infobase (Canada) ▪ NHS Modernisation Agency ▪ NHS Institute for Innovation and Improvement ▪ Royal College of Physicians ▪ Royal College of Surgeons ▪ Royal College of Anaesthetists ▪ Royal College of Nursing ▪ Intensive Care Society ▪ Intensive Care Society – Ireland ▪ Association of Anaesthetists of Great Britain and Ireland ▪ Intensive Care National Audit & Research Centre ▪ British Association of Critical Care Nurses ▪ Scottish Intensive Care Society ▪ European Society of Intensive Care Medicine ▪ Society of Critical Care Medicine (USA) ▪ Resuscitation Council	*Websites* ▪ NHS Service Delivery and Organisation (SDO) Research and Development Programme ▪ National Coordinating Centre for Health Technology Assessment (NCCHTA) *Databases* ▪ Cochrane Database of Systematic Reviews (CDSR) ▪ Cochrane Central Register of Controlled Trials (CENTRAL) ▪ Database of Abstracts of Reviews of Effects (DARE) ▪ Health Technology Assessment (HTA) Database ▪ NHS Economic Evaluation Database (NHS EED)

5.3.2 Main searches

5.3.2.1 Sources

The following sources were searched for the topics presented in sections 5.3.2.2–5.3.2.4 below.

- Cochrane Database of Systematic Reviews – CDSR (Wiley)
- Database of Abstracts of Reviews of Effects – DARE (Wiley)
- Health Technology Assessment (HTA) Database – (Wiley)
- Cochrane Central Register of Controlled Trials – CENTRAL (Wiley)
- MEDLINE (Ovid)
- MEDLINE In-Process (Ovid)
- EMBASE (Ovid)
- CINAHL (Ovid)
- PsycINFO (Ovid)
- Science Citation Index (Dialog DataStar)
- Social Science Citation Index (Dialog DataStar)
- National Research Register

5.3.2.2 Identification & evaluation of risk scoring tools

The search strategies were closely based on the strategies developed by Gao et al. (2007), and were run as updates to the Gao et al. searches. The searches were run on 30 October 2006 and limited to records added to the databases from November 2004 onwards. The MEDLINE search strategy is presented below, which was translated for use in all other databases.

MEDLINE search strategy

1 *Health Status Indicators/
2 exp *"Severity of Illness Index"/
3 *Sickness Impact Profile/
4 *Risk Assessment/
5 severity of illness ind$.tw.
6 health status ind$.tw.
7 risk assess$.tw.
8 sickness impact profile$.tw.
9 early warning.tw.
10 (warning adj2 (scor$ or system$)).tw.
11 ews.tw.
12 (mews or mew).tw.
13 (track and trigger).tw.
14 ((trigger or calling) adj5 criteria).tw.
15 *Point-of-Care Systems/
16 point of care system$.tw.
17 serious$ ill$.tw.
18 or/1-17
19 exp *Critical Care/
20 critical care.tw.
21 intensive care.tw.
22 exp *Intensive Care Units/
23 exp *Emergency Service, Hospital/
24 hospital emergency service$.tw.
25 medical emergency team$.tw.
26 met.tw.
27 hospital emergency team$.tw.
28 patient emergency team$.tw.
29 exp *Patient Care Team/
30 patient care team$.tw.
31 patient at risk$.tw.
32 par.tw.
33 (outreach adj (service$ or team$)).tw.
34 shock team$.tw.
35 or/19-34
36 18 and 35
37 200411$.ed
38 200412$.ed
39 2005$.ed
40 2006$.ed
41 or/37-40
42 36 and 41

5.3.2.3 Response strategies for patients identified as having deteriorating clinical condition

The search strategies were closely based on the strategies developed by Esmonde et al. (2006), and were run as updates to the Esmonde et al searches. The searches were run on 15 December 2006 and limited to records added to the databases from 2004 onwards. The MEDLINE search strategy is presented below, which was translated for use in all other databases.

MEDLINE strategy

1 exp Critical Care/
2 critical care$.tw.
3 Critical Illness/
*4 exp *Intensive Care Units/*
5 intensive care$.tw.
6 ((critical$ or acute$ or sever$ or sudden$ or unexpected$) adj2 ill$).tw.
7 (patient$ adj2 deteriorat$).tw.
8 (risk$ adj2 deteriorat$).tw.
9 or/1-8
*10 exp *Emergency Service, Hospital/*
11 hospital emergency service$.tw.
12 exp Patient Care Team/
13 outreach.tw.
14 patient at risk$.tw.
15 patient care team$.tw.
16 hospital emergency team$.tw.
17 patient emergency team$.tw.
18 acute pain team$.tw.
19 night nurse practi$.tw.
20 night discharg$.tw.
21 or/10-20
22 9 and 21
23 rapid response team$.tw.
24 medical emergency team$.tw.
25 23 or 24
26 22 or 25
27 2004$.ed
28 2005$.ed
29 2006$.ed
30 or/27-29
31 26 and 30

5.3.2.4 Timing of discharge from critical care areas

Searches were undertaken on 17 February 2007. The MEDLINE search strategy is presented below, which was translated for use in all other databases.

MEDLINE strategy

1 exp Critical Care/
2 exp Intensive Care Units/
3 Critical Illness/
4 or/1-3
5 exp Patient Care Planning/
6 Patient Discharge/
7 Patient Readmission/
8 Patient Transfer/
9 or/5-8
10 4 and 9
11 (critical$ adj2 care$ adj4 discharg$).tw.
12 (intensive$ adj2 care$ adj4 discharg$).tw.
13 ((ICU$ or SICU$ or MICU$ or ITU$) adj4 discharg$).tw.
14 ((critical$ or acute$ or sever$) adj2 ill$ adj4 discharg$).tw.
15 (critical$ adj2 care$ adj4 (readmit$ or re-admit$ or readmission$ or re-admission$)).tw.
16 (intensive$ adj2 care$ adj4 (readmit$ or re-admit$ or readmission$ or re-admission$)).tw.
17 ((ICU$ or SICU$ or MICU$ or ITU$) adj4 (readmit$ or re-admit$ or readmission$ or re-admission$)).tw.
18 ((critical$ or acute$ or sever$) adj2 ill$ adj4 (readmit$ or re-admit$ or readmission$ or re-admission$)).tw.
19 (critical$ adj2 care$ adj4 transfer$).tw.
20 (intensive$ adj2 care$ adj4 transfer$).tw.
21 ((ICU$ or SICU$ or MICU$ or ITU$) adj4 transfer$).tw.
22 ((critical$ or acute$ or sever$) adj2 ill$ adj4 transfer$).tw.
23 or/11-22
24 10 or 23
25 Time/
26 Time Factors/
27 Night Care/
28 After-hours Care/
29 (time$ or timing$).tw.
30 (night$ or day$ or morning$ or afternoon$ or evening$ or week$).tw.
31 ((after or out or early) adj2 hours).tw.
32 or/25-31
33 exp "Outcome and Process Assessment (Health Care)"/
34 Patient Readmission/
35 Length of Stay/
36 exp Mortality/
37 Death/
38 Death, Sudden/
39 Morbidity/
40 Survival/
41 Survival Rate/
42 Survival Analysis/
43 exp Heart Arrest/
44 Death, Sudden, Cardiac/
45 Respiratory Insufficiency/
46 Multiple Organ Failure/

47 (outcome$ or readmit$ or re-admit$ or readmission$ or re-admission$ or 'length of stay' or mortalit$ or death$ or fatal$ or morbidit$ or surviv$).tw.
48 ((cardiac or heart or respiratory or cardiorespiratory or cardio-respiratory or cardiopulmonary or cardio-pulmonary) adj2 arrest$).tw.
49 (organ$ adj2 (fail$ or dysfunction$)).tw.
50 or/33-49
51 24 and 32 and 50

5.3.2.5 Patients' experiences of care in the period immediately following discharge from critical care areas to general wards.

Searches were undertaken on 21 February 2007. The MEDLINE search strategy is presented below, which was translated for use in all other databases.

MEDLINE strategy

1 exp Critical Care/
2 exp Intensive Care Units/
3 Critical Illness/
4 (critical$ adj2 care$).tw.
5 (intensive$ adj2 care$).tw.
6 (intensive$ adj2 therap$).tw.
7 (ICU$ or SICU$ or MICU$ or ITU$).tw.
8 ((critical$ or acute$ or severe$) adj2 ill$).tw.
9 or/1-8
10 exp Patient Care Planning/
11 Patient Discharge/
12 Patient Readmission/
13 Patient Transfer/
14 discharg$.tw.
15 (readmit$ or re-admit$ or readmission$ or re-admission$).tw.
16 transfer$.tw.
17 or/10-16
18 Qualitative Research/
19 Nursing Methodology Research/
20 exp Interviews/
21 Questionnaires/
22 Narration/
23 (qualitative$ or interview$ or focus group$ or questionnaire$ or narrative$ or narration$).tw.
24 (ethno$ or emic or etic or phenomenolog$ or grounded theory or constant compar$ or (thematic$ adj3 analys$) or theoretical sampl$ or purposive sampl$).tw.
25 (hermeneutic$ or heidegger$ or husserl$ or colaizzi$ or van kaam$ or van manen$ or giorgi$ or glaser$ or strauss$ or ricoeur$ or spiegelberg$ or merleau$).tw.
26 (metasynthes$ or meta-synthes$ or metasummar$ or meta-summar$ or metastud$ or meta-stud$).tw.
27 or/18-26
28 Patients/px
29 Inpatients/px
30 Family/px
31 Caregivers/px
32 Stress, psychological/
33 Adaptation, psychological/
34 Emotions/
35 Anxiety/
36 Fear/
37 Loneliness/
38 Nursing Care/
39 Nurse's Role/
40 Aftercare/
41 Progressive Patient Care/
42 Continuity of Patient Care/
43 Subacute Care/

44 ((patient$ or famil$ or carer$ or caregiver$ or inpatient$ or in patient$) adj2 (experience$ or stress$ or adapt$ or emotion$ or anx$ or fear$ or lonel$ or concern$ or uncertain$ or unsure or thought$ or feeling$ or felt$ or memor$ or view$ or opinion$ or perception$ or satisfact$)).tw.
45 28-44
46 9 and 17 and 27
47 9 and 17 and 45
48 46 or 47
49 Hospital Units/
50 hospital unit$.tw.
51 (ward or wards).tw.
52 or/49-51
53 48 and 52

5.3.3 Health economics

5.3.3.1 Sources

The following sources were searched to identify economic evaluations:

- *NHS Economic Evaluation Database – NHS EED (via Cochrane Library, Wiley)*
- Health Economic Evaluations Database – HEED (OHE interface)
- MEDLINE (Ovid)
- *MEDLINE In-Process (Ovid)*
- *EMBASE (Ovid)*
- *CINAHL (Ovid)*
- *PsycINFO (Ovid)*
- *Science Citation Index (Dialog DataStar)*
- *Social Science Citation Index (Dialog DataStar)*

5.3.3.2 Strategies

The searches were undertaken on 30 November 2006. For NHS EED and HEED, the MEDLINE strategies presented in sections 5.3.2.2 and 5.3.2.3 were translated. For the bibliographic databases, filters to retrieve economic evaluations were appended to the search strategies used to identify the evidence for risk scoring tools and response strategies. The MEDLINE filter is presented below, which was translated for all other databases.

MEDLINE filter

1. Economics/
2. exp "Costs and Cost Analysis"/
3. Economics, Dental/

4. exp Economics, Hospital/
5. exp Economics, Medical/
6. Economics, Nursing/
7. Economics, Pharmaceutical/
8. Budgets/
9. "Quality of Life"/
10. "Value of Life"/
11. quality-adjusted life years/
12. exp models, economic/
13. markov chains/
14. monte carlo method/
15. Decision Trees/
16. economic$.tw.
17. quality of life.tw.
18. qol?.tw.
19. hrqol?.tw.
20. quality adjusted life year?.tw.
21. qaly?.tw.
22. cba.tw.
23. cea.tw.
24. cua.tw.
25. markov$.tw.
26. (monte adj carlo).tw.
27. (decision adj2 (tree? or analys$)).tw.
28. utilit$.tw.
29. pathway?.tw.
30. ((critical or clinical or patient) adj (path? or protocol?)).tw.
31. or/1-30

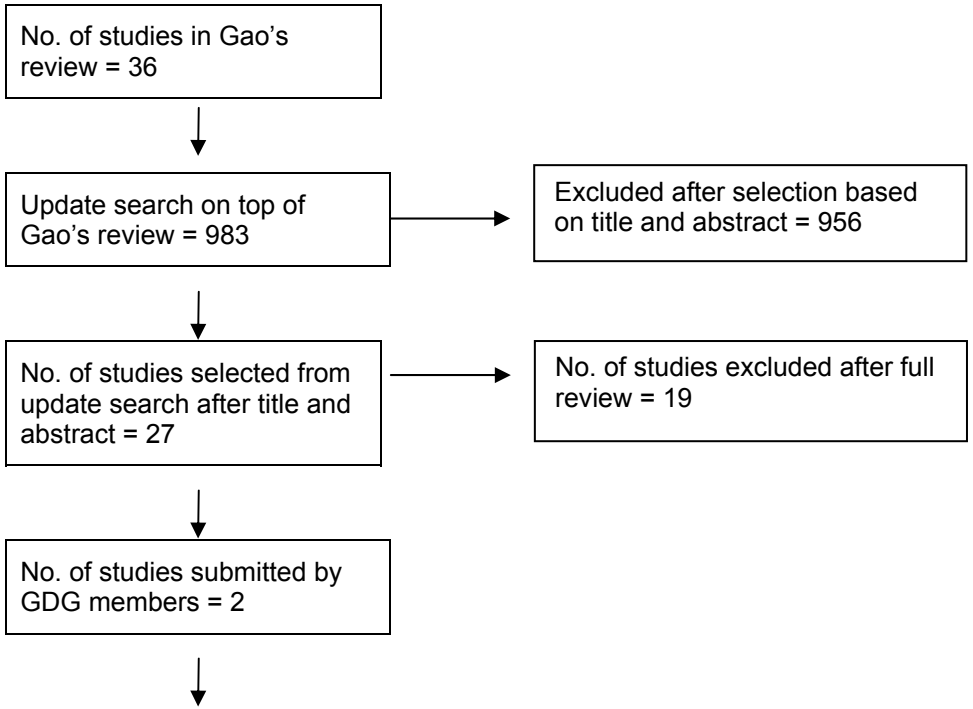
Esmonde L, McDonnell A, Ball C et al. (2006) Investigating the effectiveness of critical care outreach services: a systematic review. *Intensive Care Medicine* 32 (11) : 1713-1721.

Gao H, McDonnell A, Harrison DA et al. (2007) Systematic review and evaluation of physiological track and trigger warning systems for identifying at risk patients on the ward. *Intensive Care Medicine* 33 (4) : 667-679.

5.4 Appendix 4 – Evidence Tables

5.4.1 Topic 1: Identification and Evaluation of Risk Scoring Tool

Volume of Evidence



Total no. of included studies = 46

Acutely Ill Patient – Evidence Table

Topic 1: Identification and Evaluation of Risk Scoring Tool

KEY TO STUDY TYPE

Study type	Description
Development/validation	These studies have been analysed as diagnostic studies. Studies only included in this category if they include patients both with and **without** the reference outcome (e.g. cardiac arrest, ICU admission, mortality). Studies where the population includes patients **with the reference outcome only** have been classified as descriptive. Key distinction between development and validation is that, in development studies, identification of parameters, cut-offs, and/or design of scoring systems have been determined based on the outcomes of the study sample (e.g. through the use of ROC curves). For validation studies, these criteria have already been determined and their predictive ability is evaluated in a new sample of patients. Several included studies fall into both categories.
Intervention studies	Look at the effect on patient outcomes of introducing a scoring tool (either alone or in combination with a critical care response team). Studies have only been included in this category if they permit a comparison of outcomes both **with and without** the scoring tool e.g. randomised controlled trials, non-randomised controlled trials, before-and-after studies, cohort studies with historical control. Studies that report the implementation of a scoring tool but do not permit this comparison have been classified as descriptive.
Descriptive studies	Studies included in the Gao et al. (2007) systematic review that describe the use of a scoring tool, but do not fit into the categories outlined above.

TYPES OF SCORING TOOL (as used by Gao et al. (2007) review)

TYPE	DESCRIPTION
Single parameter system	Periodic observation of selected vital signs which are compared to a simple set of criteria with predefined thresholds, with a response algorithm being activated when any criterion is met
Multiple parameter system	Response algorithm requires more than one criterion being met or differs according to the number of criteria met
Aggregate scoring system	Where weighted scores are assigned to physiological values and compared to predefined trigger thresholds
Combination system	Involving single or multiple parameter systems in combination with aggregate weighted scoring systems.

DEVELOPMENT/VALIDATION (DIAGNOSTIC ACCURACY) STUDIES

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 22, Subbe et al. (2001), UK Cohort study Study period: 5 days Level of evidence: **(Ib)**	Acute medical admissions unit. All patients were medical emergency admissions (patients admitted directly to coronary care, HDU, or ICU were excluded). No of patients: 709 Length of follow-up: 60 days.	**TT system:** Modified Early Warning Score (MEWS). Aggregate scoring system. Parameters (5): Heart rate, respiratory rate, blood pressure, temperature, consciousness, MEWS score of 5 or more was considered 'critical'. **Response team:** Not reported. **Reference criteria:** ICU/HDU admission Attendance of cardiac arrest team	Score of 5 or more was associated with: Increased risk of death: OR 5.4 (95% CI 2.8 – 10.7) ICU admission: OR 10.9 (95% CI 2.2 – 55.6) HDU admission: OR 3.3 (95% CI 1.2-9.2).	HDU/ICU admission was at the discretion of attending physicians, who were unaware of patient's MEWS score. 2x2 table data (a,b,c,d) not reported. ROC curve presented, but sensitivity and specificity for a critical score of 5 or more not reported.

		60 day mortality		

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 1 Buist et al. (2004), Australia Prospective cohort study Study period: 33 weeks. Level of evidence: **(II)**	General wards (2medical, 2 surgical and 1 orthopaedic). DNR patients were not excluded. No of patients: 6303	**TT system:** MET calling criteria. Single parameter system Parameters (6): Heart rate, respiratory rate, blood pressure, O_2 saturation, consciousness, seizures. One or more abnormal observations triggers the system. **Response team:** Medical emergency team (MET) **Reference criteria:** In-hospital mortality	Patients with one or more abnormal observation PPV = 35% Patients with one abnormal observation only PPV = 16.2% Patients with 4 or more abnormal observations. PPV = 88.2% Univariate logistic regression found that the strongest predictors of mortality was: decrease in respiratory rate Multiple logistic regression identified 6 significant predictors of mortality: Decrease of consciousness, loss of consciousness, hypotension, decreased respiratory rate, O_2 saturation, and decreased heart rate.	564 study patients experienced 1598 pre-determined clinically abnormal events.146 of these patients subsequently died. Number of deaths for patients who did not trigger the system is not reported, therefore sensitivity, specificity, and negative predictive value could not be calculated. Medical emergency team responded to all abnormal observations and intervention may have averted death, therefore estimate of test accuracy may be lower?

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 5, Goldhill and McNarry (2004), UK Cohort study Study period: 1 day (with 30 day follow-up) Level of evidence: **(II)**	Non-obstetric beds (excluded ICU pts and known DNRs). 548 patients. Length of follow-up: 30 days	**Parameters assessed:** PART calling criteria (based on EWS). Parameters (7): heart rate, respiratory rate, blood pressure, temperature, urine, O_2 saturation, consciousness. **Response team:** Patient at risk team (PART). ICU outreach team. **Reference criteria:** 30-day mortality	Stepwise multiple logistic regression identified 5 significant variables (in decreasing significance): Level of consciousness, heart rate, age, blood pressure, and respiratory rate. Results, based on this model: Sensitivity: 7.7% Specificity: 99.8% Positive predictive value: 66.7%	Study does not report the use of a specific scoring system, but physiological parameters assessed (points awarded for increasing abnormality) and normal ranges used were the patient at risk team (PART) criteria, (with the addition of temperature). 2x2 table data (a,b,c,d) not reported. Mortality increased with the number of physiological abnormalities ($p<0.001$).

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 18, Hodgetts et al. (2002), UK Case-control study (cases were consecutive, controls randomly selected). Study period: 2 weeks Level of evidence: **(II)**	Hospital patients (included wards and critical care areas). Cases: 118 pts Controls: 132 pts	**Parameters assessed:** Risk factors for cardiac arrest, identified from case-notes review. Parameters (10): Heart rate, respiratory rate, blood pressure, temperature, O_2 saturation, concern, breathing indicator, chest pain, abdominal pain, gender **Response team:** Not reported. **Reference criteria:** In-hospital cardiac arrest (defined as CPR attempted).	MET activation criteria were grouped and weighted by a panel of experts and a cumulative scoring system developed. Score of 1 Sensitivity: 100% Specificity: 17% Score of 2-3 Sensitivity: 98 – 94% Specificity: 36 – 61% Score of 4 Sensitivity: 89% Specificity: 77% Score of 5-7 Sensitivity: 84 – 64% Specificity: 89 – 96% Score of 8 Sensitivity: 52% Specificity: 99%	Aim of study is to identify significant predictors of cardiac arrest to inform the development of MET calling criteria. Ward and critical care patients would have received different levels of monitoring and intervention. Parameters assessed from case-notes review. Graded clinical response outlined based on score. If a patient achieves a score of 8 or higher the MET team is called out. Case-control study designs result in inflated estimates of diagnostic test accuracy.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 259, Bell et al. (2006), Sweden Cohort study. Length of study: 2 days (4 months apart). Level of evidence: **(II)**	General wards (psychiatric wards and ICU excluded). Length of follow-up: 30 days. No of patients: 895	**TT system:** Single parameter system. Parameters (4): heart rate, respiratory rate, blood pressure, consciousness. If a patient triggers the chief ward nurse is informed. **Response team:** Not reported **Reference criteria:** 30 day mortality 6 month mortality	30 day mortality: Sensitivity: 33.3% specificity: 96.5% PPV: 33.3% NPV 33.3% LR+: 9.51 LR-: 0.69 6-month mortality: Sensitivity: 37.5% specificity: 87.3% PPV: 12.1% NPV: 96.8% LR+:2.96 LR-: 0.72	Study carried out during the planning phase before implementing a medical response (MET) team in the hospital. Patients were excluded if they were not on the ward at the time of data collection, they refused to participate, or ward nurse/doctor felt it was inappropriate. A more restricted and an extended set of criteria (based on broadening or shortening the normal ranges for heart rate, respiratory rate, and BP) were also evaluated, but full results not reported. Authors report that the original parameter levels (taken from Bellomo 2004, ID6) had the greatest accuracy.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 1022, Goldhill et al. (1999), UK Cohort study Study period: 6-months Level of evidence: **(III)**	Hospital wards 63 patients (69 assessments made) Length of follow-up: death or discharge.	**TT system:** PART calling criteria (based on MEWS). Multiple parameter system. Parameters (6): heart rate, respiratory rate, blood pressure, urine, O_2 saturation, consciousness. Response based on number and combination of parameters triggered. **Response team:** Patient at risk (PART) ICU outreach team. **Reference criteria:** ICU admission.	Patients with one abnormal observation: Sensitivity: 97% Specificity: 18% Patients with two abnormal observations: Sensitivity: 80% Specificity: 41% Patients with three abnormal observations: Sensitivity: 27% Specificity: 67%	Main criteria: Patient triggers if they have 3/6 abnormal physiological parameters Secondary criteria: patient triggers if they have reduced consciousness plus either increased heart or respiratory rate (cut-off values higher for latter two variables than for main criteria). 2x2 table data (a,b,c,d) not reported.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 296, Lam et al. (2006), Hong Kong Cohort Study length: 1 month. Level of evidence: **(II)**	Emergency department observation ward (EDOW). No. of patients: 427 (diagnostic accuracy results appear to be based on data from 94 patients admitted hospital ward or ICU). Length of follow-up: 30 days	**TT system:** Modified Early Warning Score (MEWS). Aggregate scoring system Parameters (5): Heart rate, respiratory rate, blood pressure, temperature, consciousness Critical score > 4. Patients highest MEWS score reached during EDOW admission was defined as 'ScoreMax'. **Response team:** Specialist emergency physicians who worked on the ward. **Reference criteria:** Serious outcome (defined as death and/or ICU admission).	ScoreMax >4 Sensitivity: 60% (95% CI =15-94%) Specificity: 97% (95% CI =95-98%) ROC curve analysis suggested that ScoreMax > 3 performed best Sensitivity:100% (95% CI =48-100%) Specificity: 97% (95% CI = 85-91%) ROC curves of different physiological parameters and ScoreMax were compared for predicting serious outcome. Area under curve highest for ScoreMax (0.96). ROC curves of different physiological parameters and ScoreMax were compared for predicting hospital admission (based on 425 patients) Area under curve highest for respiratory rate (0.77).	2 patients with incomplete epidemiological or discharge data were excluded. Ward physicians who decided whether patients should be admitted to wards or ICU were unaware of MEWS scores. Unclear whether 30-day mortality assessed in patients not admitted.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 575, Garcea et al. (2006), UK Cohort study (retrospective) Study period: 3 years approx? (2002 to 'present'). Level of evidence: **(III)**	110 Patients admitted with acute pancreatitis Length of follow-up: episode of pancreatitis (no info about how this was defined)..	**TT system:** Early Warning Score (EWS). Aggregate scoring system. Parameters (6): Heart rate, respiratory rate, blood pressure, temperature, consciousness. Critical score was ≥ 3. **Response team:** Not reported. **Reference criteria:** Mortality	Day 1 Sensitivity: 85.7% (95% CI 42.2-97.6%) Specificity: 28.3% (95% CI 19.7-38.2%) NPV: 94.3% Day 2 Sensitivity: 71.4% (95% CI 28.3-90.5%) Specificity: 67.4% (95% CI 57.1-76.5%) NPV: 98.3% Day 3 Sensitivity: 100% (95% CI 54.1-100%) Specificity: 77.4% (95% CI 67.6-85.4%) NPV: 100%	APACHE scores. ASA grade, Ranson score, Imrie score and CT grades also recorded for all patients. Length of patient follow up. Results also presented for "Adverse outcome", defined as death, necrosectomy, or critical care admission. ROC curve analysis found that EWS was the best predictor adverse outcomes in the first 24hrs of admission.

Study details & Level of evidence	Patients and setting	Tools evaluated and reference criterion	Results	Comments
ID 2501 Gao et al. (2007) Cohort study. Study length: variable by dataset Level of evidence: **(III)**	Acute NHS hospitals in England with critical care services. Patients < 12 were excluded. 15 datasets included.	**TT systems:** Single parameter systems (1) Combination systems (4) Aggregate scoring systems (10) **Parameters:** All TTs included heart rate, respiratory rate, systolic blood pressure, and level of consciousness, but varied in terms of other parameters, assignment of scores to physiological values, and trigger thresholds. Variation between datasets existed in the physiological measurements and outcomes. For tools with graded responses a trigger event was defined as any response involving informing a more experience member of staff. **Reference criterion:** Presence of established critical illness (defined as composite of death, admission to critical care, DNR, or CPR).	Median (IQR) sensitivity: 43.3 (25.4-69.2) Median (IQR) specificity: 89.5 (64.2-95.7) Median (IQR) PPV: 36.7 (29.3-43.8) Median (IQR) NPV: 94.3 (89.5-97.0) ROC curve analysis: area under the ROC curve ranged from 0.61-0.84 Meta-regression of 12 datasets: Differences in diagnostic accuracy among the datasets were not explained by the physiological parameters included in the TT.	Unclear whether some of the datasets were from critical patients only. Meta-regression done on datasets that included critical care follow-up, or all ward/MAU patients were identified. Currently unpublished.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
Updated search: ID: 3399, Cuthbertson et al. (2007), UK Comparative cohort study Study period: 7 weeks (1st July till 15th August 2003). Level of evidence: **(II)**	A teaching hospital in Scotland. All patients from the surgical high dependency units in Aberdeen Royal Infirmary (2 cohorts: 1 required ICU admission, 1 did not). Total no. of patients = 136 ICU group = 67 HDU group = 69	**TT system:** Individual physiological parameters (6): Heart rate, respiratory rate, systolic blood pressure, temperature, oxygen saturation, urine volume & consciousness level using Alert (AVPU scale). Multiple parameters & aggregate scoring systems (3): PART, EWS, MEWS. **Exclusions: (1) parameters that had less than 60% of complete data points, (2) urine volume was excluded due to large amount of missing data.* **Response team:** No response team. **Reference criteria:** ICU admissions.	<u>Differences in physiological parameters in the ICU and HDU groups:</u> Heart rate: p = 0.0001, AUC: 0.74, Sensitivity = 67, Specificity = 77, cut point = 90 Respiratory rate: p = 0.0001, AUC: 0.82, Sensitivity = 70, Specificity = 86, cut point = 20 Oxygen saturation: p = 0.0001, AUC: 0.79, Sensitivity = 66, Specificity = 86, cut point = 96 Systolic blood pressure: p = 0.77, AUC: 0.51 *[not significant]* Temperature: p = 0.81, AUC: 0.51 *[not significant]* EWS: p = 0.0001, AUC: 0.86, Sensitivity = 81, Specificity = 84, cut point = 3 MEWS: p = 0.0001, AUC: 0.83, Sensitivity = 72, Specificity = 84, cut point = 3 PART: p = 0.0001, AUC: 0.84, Sensitivity = 65, Specificity = 89, cut point = 2 <u>Discriminant analysis:</u> There were 3 canonical discriminant functions (*f*1 with 5 parameters, *f*2 with 3 parameters & *f*3 with 2	The findings of this study showed that HH, RR & SaO_2 were powerful physiological parameters for determining the difference between patients requiring ICU admission. Only 7 weeks study period. Only covered a cohort of surgical patients and the sample was small. One parameter (urine volume) was discarded due to large amount of missing data. This could have affected the outcomes of the discriminant analysis. The author commented that one of the weaknesses of this study is the use of ICU admission as the end point

			parameters) applied to every subject for all time periods. The area under ROC were *f*1 = 0.81, *f*2 = 0.80, *f*3 = 0.75 respectively. Consequently, *f*2 (HH, RR, SaO_2) was seen to perform as well as *f*1 despite containing fewer variables. When comparing differences in the 48 hours before ICU admission, HR & RR could differentiate between groups for up to 7 & 8 hours before ICU admission. However, *f*2 and SaO_2 could differentiate between groups for up to 48 hours before ICU admission. Function *f*2 was as powerful at differentiating between groups at 24 hours as it was at 2 hours. The existing scoring systems (EWS, MEWS, PART) were good discriminators but with larger number of parameters and large number of rules (24, 29 & 20 respectively).	rather than other ward based deteriorations as study end points such data was deemed to be unclean data and was not suitable to be analysed.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
Updated search: ID: 635 Goldhill et al. (2005), UK cohort study Study period: Between 17 August 2001 and 27 January 2003. Level of evidence: **(III)**	UK hospital. 2 groups of patients: Primary referrals from the wards of any patient causing concern or who triggered PART, and, patients discharged to a ward from ICU. Total no. of outreach service episodes = 1047	**TT system:** Patient-at-risk (7): Heart rate, respiratory rate, systolic blood pressure, temperature, oxygen saturation, urine volume & consciousness level **Response team:** Patient-at-risk team (PART) **Reference criteria:** Hospital mortality.	Association between PAR score (of > 0) and hospital mortality = chi-squared for trend, $p < 0.0001$ Ability of PAR to discriminate between patients who needed intervention from those who did not: area under ROC curve = 0.822	Study included only those patients already selected to receive outreach care, and therefore were likely to be among the sickest patients in the hospital. The author commented that selecting a suitable trigger score will determine the outreach service workload. Study findings might also have been different if other thresholds had been selected.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
Updated search: **emergency paper* ID: 242 Subbe et al. (2006), UK Retrospective cohort study Study period: Group 1: 2 days Group 2: 7-month Group 3: 7-month Level of evidence: **(III)**	UK hospital. 3 groups of patients: Group 1 – unselected emergency department (ED) admissions. Group 2 – from ED to ICU. Group 3 – from ED to general wards then ICU. No. of patients: Group 1 = 53 Group 2 = 49 Group 3 = 49	**TT systems:** MEWS (5): systolic blood pressure, pulse rate, respiratory rate, temperature, level of consciousness. Critical score ≥ 3 ASSIST (5): systolic blood pressure, pulse rate, respiratory rate, level of consciousness, age (extra point with patient > 70 years old). Critical score ≥ 4 MET (5): blood pressure, heart rate, respiratory rate, level of consciousness. Critical score: single call-out parameter. **TT systems were compared with MTS (Manchester Triage System): blue, green, yellow, orange, red.* **Response team:** None. **Reference criteria:** ICU admissions.	<u>Sensitivity of scoring systems for ICU admission:</u> MTS (orange or red): Group 1 = 46 (96%) Group 2 = 32 (65%) MEWS (>2): Group 1 = 34 (77%) Group 2 = 24 (55%) ASSIST (>3): Group 1 = 11 (22%) Group 2 = 8 (16%) MET (=1): Group 1 = 1 (2%) Group 2 = 3 (7%) <u>Groups Comparisons:</u> *In group 2, MTS identified 42 sick patients; MEWS, ASSIST & MET would not have identified any additional sick patients. *In group 3, MTS identified 28 sick patients; MEWS would have identified an additional 7 patients; ASSIST & MET would not have identified any additional sick patients.	The findings suggested that the introduction of a physiological TT scoring system would have identified only a small number of additional patients as critically ill and added little to the triage system currently in use. Analysis on Specificity not reported. There was no actual utilization of the scoring systems, physiological data was retrieved from database and then was used to run the calculations of the three scoring systems and then analyses were carried out. The author commented that this is a small scale non-randomised study, and the study did not assess or score 'pain' as 'pain' could be a powerful

				confounding variable that influences the value of physiological parameters, and pain relief would have altered subsequent measurements.

Study details & Level of evidence	**Setting and patients**	**Tool evaluated and reference**	**Results**	**Comments**
Updated search: **reproducibility paper* ID: 7439 Subbe et al. (2007) Prospective cohort study Level of evidence: **(II)**	UK hospital. <u>Inter-rater reliability study:</u> 2 medical wards & 2 surgical wards = 114 patients, 424 datasets, 4 raters. Intra-rater reliability study: 1 medical ward & 1 surgical ward = 45 patients, 180 datasets, 4 raters.	**TT systems:** MET (5): blood pressure, heart rate, respiratory rate, level of consciousness. Critical score: single call-out parameter. MEWS (6): systolic blood pressure, pulse rate, respiratory rate, temperature, level of consciousness, urine. Critical score ≥ 3 ASSIST(5): systolic blood pressure, pulse rate, respiratory rate, level of consciousness, age (extra point with patient > 70 years old). Critical score ≥ 4 **Response team:**	MET achieved higher percentage agreement than ASSIST, and ASSIST higher than MEWS. <u>Level of agreement (inter-rater study):</u> (Trigger) MET: Kappa = -0.03 (95% CI: -0.05-0.00) MEWS: Kappa = 0.18 (95% CI: 0.09-0.27) ASSIST: Kappa = 0.20 (95% CI: 0.04-0.38) (Score) MEWS: Kappa = 0.20 (95% CI: 0.13-0.27) ASSIST: Kappa = 0.46 (95% CI: 0.38-0.55) <u>Level of agreement (intra-rater study):</u> (Trigger) MET: Kappa = -0.01 (95% CI: -0.02- -0.01) MEWS: Kappa = 0.64 (95% CI: 0.46-0.84) ASSIST: Kappa = 0.66 (95% CI: 0.04-0.38) (Score) MEWS: Kappa = 0.53 (95% CI: 0.39-0.68) ASSIST: Kappa = 0.59 (95% CI: 0.46-0.74)	The study suggested that there was significant variation in the reproducibility of physiological track and trigger warning systems used by different health care professionals. All three systems examined showed better agreement on triggers than aggregate scores. Simpler systems had better reliability. Repeated measurements were taken within an hour in this study and it did not assess whether there was systematic drift of figures between measurements. Approximately 5% of all

		None. **Reference criteria:** Reproducibility	Intra-rater reliability was better then inter-rater reliability. Using corrected calculations improved the level of inter-rater agreement but not intra-rater agreement. The systems examined showed better levels of agreement on triggers than on aggregate scores.	potential patients were not included in the study (consent not obtained). Urine output was excluded in the study due to large amount of missing data. The findings only represent the human element of reliability (as BP & temperature were measured with electronic devices).

INTERVENTION STUDIES

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 154, Hillman et al. (2005), Australia Cluster-RCT Study period: 6-months Level of evidence: **(Ib)**	General wards (including coronary care unit, and HDU not under supervision of intensive care specialist). Intervention: 12 hospitals. Median no. of admissions 18512 (range 2667-33 115) Control: 11 hospitals. Median no. of admission 17555 (range 5891-22338)	**TT system:** Parameters (8): Heart rate, respiratory rate, blood pressure, consciousness, concern, cardiac arrest, respiratory arrest, repeated/extended seizures **Response team:** Medical emergency team (MET) including at least one doctor and nurse from the emergency dept or ICU. Staffing varied between hospitals, but study protocol required that the team be at least the equivalent of the pre-existing cardiac arrest team. **Response algorithm:** Staff call out the MET when patient triggers. **Other intervention:** 4-month education strategy for clinical and medical staff about calling criteria and how to call MET, including lectures, video, and booklets (did not include treatment of critically ill or unstable patients). Reminders (prior to introduction of system)	'Usual care'. Cardiac arrest teams	Incidence of cardiac arrests (per 1000 patients) Defined as arrest without a pre-existing DNR order. Unplanned ICU admissions (per 1000 patients). Unexpected deaths (per 1000 patients) Defined as death without a pre-existing DNR.	Int: 1.31 Comp: 1.64 p value: 0.306 Int: 4.19 Comp: 4.68 p value:0.899 Int: 1.06 Comp: 1.18 p value: 0.564	Before-and-after analysis also carried out, using on baseline data collected during a 2-month period before the study began. A significant reduction in rate of cardiac arrests and unexpected deaths was seen for both groups combined. Investigators observed low rates of MET calls preceding unplanned ICU admissions and unexpected deaths where MET criteria were documented, suggesting implementation could have been improved.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 3, Priestley et al. (2004), UK Cluster-RCT Length of study period: 12-weeks. Level of evidence: **(II)**	16 adult wards (8 surgical, 5 medical and 3 elderly care) 2903 patients. Length of follow-up: discharge or death.	**TT system:** 'patient at risk' score. Aggregate scoring system Parameters (5): Heart rate, respiratory rate, blood pressure, urine, consciousness **Response team:** Critical care outreach team (CCOT). 24-hr cover. Nurses only. Responses included support and advice for ward staff, individual care of patient during crisis period, facilitation of ICU admission. **Response algorithm:** Trigger score referred to CCOT and patient's consultant. Level of involvement of CCOT determined by discussion with ward staff and admitting team. Ward staff could also seek CCOT guidance in absence of trigger score if they were concerned about the patient. **Other intervention:** 4 weeks training for all nurses and doctors on ward prior to introduction of CCOT. Care of critically ill patients, and use of scoring tool.	'Usual care' (not described).	In-hospital mortality: (Logistic regression analysis) Length of stay (defined as from study ward admission to discharge from hospital).	Intervention vs control: OR = 0.52 (95%CI 0.50-0.97) Intervention vs control: Hazard ratio: 0.90 (95%CI 0.84-0.97).	Phased introduction of the CCOT using matched pairs of wards. In each ward 4 weeks of training were given prior to introduction of team. One from each pair randomised to earlier phase of introduction. Possibility of contamination between wards. PAR is a simplified version of Subbe (2001, ID 22). No information on frequency of monitoring.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 2, DeVita et al. (2004), US Before and after study (retrospective) Level of evidence: **(III)**	All hospital sites, except ICU, emergency dept, and recovery. 3269 MET responses. Control period: 5 years. Intervention period: 1.75 years.	**TT system:** Single parameter system. Parameters (12): Heart rate, respiratory rate, blood pressure, O_2 saturation, consciousness, colour change, pain, respiratory difficulty, suicide attempt, uncontrolled bleeding, unexplained agitation **Response team:** Medical emergency team (MET). 8 members, including physicians, nurses and a respiratory therapist. Lead by ICU physician. **Response algorithm:** Any hospital staff member who witnesses grave clinical deterioration, operator pages MET. **Other intervention:** Audit and feedback of adherence to protocol for calling MET team.	**Response team:** As for intervention **Response algorithm:** As for intervention	Incidence of MET responses: (per 1000 admissions) Incidence of cardiopulmonary arrest: (per 1000 admissions) determined by hospital records of 'code' team activation Proportion (%) of arrests that were fatal: -Death on same day as arrest -Arrest without survival to discharge.	Int: 25.8 Comp: 13.7 p value: p<0.01 Int: 5.4 Comp: 6.8 p value: p=0.016 Int: 33.3% Comp: 33.3% p value: n.s. Int: % Comp: 33.3% p value: n.s.	Time period during which death (fatal cardiopulmonary arrest) was analysed prior to the introduction of the TT system was 23 months. No info on frequency of monitoring or who should be monitored. No info on MET hours of operation. Analysis for secular changes found no significant trends.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 6, Bellomo et al. (2004), Australia Before and after study Control period: 4-months Intervention period: 4-months Level of evidence: **(III)**	All wards. Acute hospital. 2436 Patients who had major surgery (hospital stay >48 hrs) Control: 1116 pts. (1369 ops.) Intervention: 1067 pts. (1313 ops.) Length of follow-up: discharge or death	**TT system:** Single parameter system Parameters (7): Heart rate, respiratory rate, blood pressure, urine, O_2 saturation, consciousness, concern. **Response team:** Medical emergency team (MET). Intensive care fellow and intensive care nurse. ICU specialist available and would attend, if requested between 08.00 – 20.00. outside of these hours, intensive care specialist would attend within 15-30 mins if required. MET carried drugs and equipment for resuscitation and endotracheal intubation. If patient not transferred to ICU, visit was treated as a formal consult and concerns, advice, and suggestions were verbally communicated to parent unit, and recorded in patient's chart **Response algorithm:** If patient triggers, MET is called to attend. *(continued over)*	**Response team:** Emergency response system based on cardiac arrest team.	All adverse events: Acute myocardial infarction: (chest pain, ECG changes, at least one elevated CK concentration) Pulmonary embolism: Clinical suspicion confirmed by V/Q scan. Respiratory failure: (need to institute mechanical breathing in ICU)	All reported as % of patients Int: 17% Comp: 30.1% p value: < 0.0001 Int: 1% Comp: 1.9% p value: n.s. Int: 0.01% Comp: 0.04% p value: n.s. Int: 1.4% Comp: 6.7% p value: <0.0001	No information on how often patients were monitored. Same study as Bellomo et al. (2003) (ID 10), which reports data for cardiac arrests only (no of arrests, fatal arrests, and no. of post-arrest bed days).

		Other intervention: Presentations and discussions with medical staff to introduce MET system, followed by 2 month 'run-in' period.		Stroke: (clinical symptoms and neurological exam, confirmed by CT or MRI Severe sepsis: (clinical suspicion, hypotension, positive blood culture). Acute renal failure: (acute need for continuous renal therapy) Emergency ICU admissions. Death Length of stay (mean):	Int: 0.3% Comp: 1.7% p value: 0.0026 Int: 0.3% Comp: 1.6% p value: 0.0044 Int: 0.02% Comp: 2.4% p value: 0.0001 Int: 4.5% Comp: 8% p value: 0.01 Int: 4% Comp: 6.5% p value: 0.0178 Int: 18.9 days (±35.3) Comp: 23.8 days (±56.5) p value: 0.092	

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 12, Pittard (2003), UK Before and after study Control period: 6-months. Intervention period: 6-months Level of evidence: **(III)**	Three surgical wards and surgical high dependency unit	**TT system:** Aggregate scoring system. Parameters (7): Heart rate, respiratory rate, blood pressure, urine, O_2 saturation, consciousness, respiratory support/oxygen therapy. Tool used by ward staff as part of routine observations. **Response team:** Critical care outreach service comprising senior critical care nurses and medical staff. Available 09.00-17.00 Mon-Fri. Team review patient and facilitate appropriate management, of arrange admission to ICU. Team also carry out daily ward round to see patients discharged from ICU. **Response algorithm:** Graded response based on severity of score and time elapsed from identification. Initially call junior member of ward and outreach staff, then call more senior staff, then call consultant, outreach team and contact ICU	'Usual care' (not described).	Unplanned admission to ICU rate: Mean length of ICU stay for unplanned admissions Readmissions to ICU	% of patients Int: 43% Comp: 58% p value: =0.05 Int: 4.8 days Comp: 7.4 days p value: n.s. Int: 3.3% Comp: 5.1% p value: 0.05	Scoring tool based on MEWS (Stenhouse . No information about frequency of monitoring required. Total number of patients on the wards during the study periods are not reported. 273 patients were seen by the outreach team during the intervention period.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 13, Subbe et al. (2003), UK Cohort study (with historical control) Intervention period: 3-months Control period: 1-month Level of evidence: **(III)**	Medical admissions unit. Patients >15 yrs referred by GP or A&E. (exclusions – coronary care, palliative care only, or admitted directly to other wards). No of patients: Int:1695 Control: 659 Length of follow-up: death or hospital discharge	**TT system:** Aggregate scoring system. Parameters (5): Heart rate, respiratory rate, blood pressure, temperature, consciousness **Response team:** Critical care outreach team (not described) **Response algorithm:** Patients with score >4 were referred for urgent medical and critical care outreach team review. **Other intervention:** All unit nursing staff were trained by investigators and outreach team to collect bedside observations and calculate MEWS score.	Usual care (includes possibility of referral to critical care outreach team). No early warning system.	% Admission to ICU % Admission to HDU % in-hospital mortality (within 30 days) % cardiopulmonary arrests length of stay on ICU ICU mortality APACHEII scores on ICU admission	Int: 0.5% Comp: 0.9% p value: n.s. Int: 4.6% Comp: 3.2% p value: n.s. Int: 9.7% Comp: 8% p value: Int: 2.3% Comp: 0.6% p value: not reported Int: 2 (IQ-range 1-30) Comp: 4 (IQ-range 1-8) p value: 0.3 Int: 33% Comp: 67% p value: 0.21 (very small sample size) Int: 15 (s.d.8) Comp: 23 (s.d.7) p value: <0.06	Historical control data obtained in from the same unit in the previous year (Subbe 2001, ID 22). TT system based on the MEWS score. Patients were classified, based on score as low (0-2), medium (3-4), or high (>4) risk. Respiratory rate was the best discriminator in predicting high-risk scores.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 14, Foraida et al. (2003), US Before and after study Control period: 2 years Intervention period: 1 year Level of evidence: **(III)**	Entire hospital (no paediatric, obstetric, or gynaecology services) Length of follow-up: N/A	**TT system:** Single parameter system. Parameters (19): Heart rate, respiratory rate, blood pressure, O_2 saturation, consciousness, bleeding into airway, breathing difficulty, colour change, lethargy/difficulty walking, naxolone use without response, pain, seizure, sudden collapse, sudden loss of movement, suicide attempt, trauma/chest pain/stroke, uncontrolled bleeding, unexplained agitation **Response team:** Medical emergency team (Condition C). Multidisciplinary team. **Response algorithm:** When patient triggers, caregiver calls crisis number and operator pages the response team, who respond within 90 secs. **Other intervention:** Reviews of sequential stat pages (disorganised responses);	**Response team:** Medical emergency team (Condition C). Multidisciplinary team. Caregiver contacts operator to call-out the response team.	Monthly average no of condition Cs Incidence of cardiopulmonary arrests (per 1000 pts). Incidence of fatal cardiopulmonary arrests (per 1000 pts).	Control: 32.3 (95% CI 27.0-37.7) Intervention: no of condition Cs increased by 19.2 (95% CI 12.1-26.3). Actual values not reported p value: < 0.0001 Int: 5.2 Cont: 6.0 p value: n.s. Int: 4.3 Cont: 2.2 p value: <0.0001	Hospital also has a condition A (arrest – cardiopulmonary) response. Condition C (crisis) refers to any other crisis situation. Feedback about disorganised responses and inappropriate delays was being given before introduction of the TT system but analyses suggested these initiatives did not affect outcomes.

		feedback to caregivers regarding delays in crisis team activation; dissemination of calling criteria through e-mail, posters, and oral presentation.				

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 17, Odell et al. (2002), UK Before and after study Control period: 7-months Intervention period: 3-months Level of evidence: **(III)**	Surgical wards (including an emergency surgical admissions unit). Length of follow-up: N/A	**TT system:** Aggregate scoring system Parameters (5): Heart rate, respiratory rate, blood pressure, urine, consciousness. Incorporated into observation charts. **Response team:** Outreach service run by 1.2 G grade sisters, and facilitated by critical care nurse consultant. Operating hours 08.00-16.00 Mon-Fri. Outside of hours ICU offers limited ward service. Outreach activities include advising about therapeutic interventions, observation, medication, nursing issues and optimum positioning for the patient. **Response algorithm:** High score (>3) triggers referral to patient's medical team and outreach staff. Patient should be seen within 30 mins. **Other intervention:** None	**Response team:** As described for intervention period.	Number of outreach visits	Int: 976 (mean 139/month) Comp: 546 (182/month) p value: Not reported (Study does not report how many pts passed through the wards during each period, therefore p value could not be calculated)	Scoring tool based on MEWS. Outreach service already in place, before the implementation of the scoring tool. Concern about respiratory rate (52%) and heart rate (24%) generated most of the outreach calls.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 19, Buist et al. (2002), Australia Before and after study Control period: 1 year (1996) Intervention period: 1 year (1999) Level of evidence: **(III)**	Entire hospital No. of pts. Cont: 19317 Int: 22847 Length of follow-up: death or discharge	**TT system:** Single parameter system Parameters (14): Heart rate, respiratory rate, blood pressure, O_2 saturation, consciousness, concern, agitation/delerium, airway threatened, difficulty speaking, failure to respond to treatment, repeated/prolonged seizures, respiratory distress, unable to get prompt assistance, uncontrolled pain **Response team:** Medical emergency team (MET) comprising two doctors (medical registrar and intensive care registrar) and one senior intensive care nurse. Attend patient immediately with resuscitation drugs, fluid, and equipment. **Response algorithm:** MET called immediately if the patient has a trigger score. **Other intervention:** Formal education, audit and feedback.	'Traditional' system of response. Nurse contacts most junior member of medical team, who reviews patient and institutes treatment. If patient continues to be unstable, junior doctor contacts next most senior member of team.	Incidence of unexpected cardiac arrests (per 1000 pts). Defined as staff member concerned enough about patient to make a cardiac arrest call (excluded DNR patients) % of cardiac arrests that were fatal No. of unplanned admissions to ICU (per 1000 patients)	Int: 2.05 Comp: 3.77 p value: <0.001 Int: 55.3% Comp: 76.7% p value: <0.001 Int: 3.4 Comp: 2.3 p value: n.s.	MET team and scoring system introduced gradually from 1997. Formal education, audit and feedback carried out in 1999.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 25, Bristow et al. (2000), Australia Cohort study Study period: 6-months Level of evidence: **(III)**	Adults (>14) admitted to hospital. Intervention: 1 hospital Control: 2 hospitals	**TT system:** Single parameter system Parameters (8):Heart rate, respiratory rate, blood pressure, consciousness, concern, cardiorespiratory arrest, repeated/prolonged seizures, threatened airway. **Response team:** Medical emergency team (MET), consisting of ICU registrar and senior nurse, and medical registrar. **Response algorithm:** MET team called if patient triggers **Other intervention:** Education programme to explain the METs role.	Conventional cardiac arrest team. Team (consisting of ICU registrar, medical registrar, and ICU or coronary care nurse) called out when patient has cardiorespiratory arrest.	Cardiac arrest Unanticipated ICU/HDU admission: (Defined as admission to ICU/HDU for reason other than the reason for hospital admission).	Control 1 vs intervention: OR = 1.24 (95%CI 0.87-1.78) p value: n.s. Control 2 vs intervention: OR = 1.05 (95%CI 0.82-1.33). p value: n.s. Control 1 vs intervention: OR = 2.17 (95%CI 1.65-2.78) p value: significant (n.r.) Control 2 vs intervention: OR = 2.35 (95%CI 1.82-3.04) p value: significant (n.r.)	Odds ratios adjusted for case-mix differences within the hospitals. Intervention hospital is the reference for the Odds ratios. P values not reported.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID260 Paterson et al. (2006), UK Before and after study Control period: 11 days Intervention period: 11 days Level of evidence: **(III)**	Emergency medical and surgical admissions to a combined assessment area (CAA) Intervention: 435 pts. Control: 413 pts.	**TT system:** Aggregate scoring system. Parameters (6):Heart rate, respiratory rate, blood pressure, temperature, O_2 saturation, consciousness. **Response team:** Not reported. **Response algorithm:** Escalating response prompting more frequent observation and urgent medical assessment. **Other intervention:** Education program for staff prior to introduction. Simple patient management guidelines on reverse of score sheet for first responders.	Use of existing conventional observation charts.	In-hospital mortality Length of hospital stay: median and IQ range. No of critical care admissions:	Int: 13/434 (3%) Comp: 24/413 (5.8%) p value: =0.046 Int: 2 (1-6) Comp: 2 (1-6) p value: n.s. Int: 11 (2.5%) Comp: 11 (2.6%) p value: n.s.	Scoring tool modified from MEWS, to include Oxygen saturation. Effect of introduction of SEWS chart on standard of documentation also examined. Overall documentation of physiological parameters significantly improved following introduction of SEWS (p<0.001)

DESCRIPTIVE STUDIES

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 7, Lee et al. (1995). Australia Level of evidence: **(III)**	To describe the utilisation and outcome of medical emergency team (MET) interventions.	375-bed teaching hospital. All wards, emergency dept, and critical care areas.	Single parameter system. Staff may alert the MET using any one of three pre-defined criteria: 1. specific conditions (cardiovascular, respiratory, shock, poisoning/trauma, neurological, obstetric, surgical) 2. physiological (6) /pathological abnormalities (5) (heart rate, respiratory rate, blood pressure, temperature, urine, consciousness, base excess, blood sugar, pH, potassium, sodium) 3. “any time urgent help required”.	Not a comparative study. One year study period. 522 MET calls recorded. Emergency dept (62%), ward (29%), critical care areas (9%). Cardiopulmonary arrest accounted for 28% of MET calls. Specific condition criteria used to alert MET in 48% of cases. Physiological or pathological criteria in 23% cases. Main alerting physiological abnormalities were decreased level of consciousness (42%) and blood pressure (29%).

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 21, Parr et al. (2001), Australia Level of evidence: **(III)**	To describe the reasons for, and immediate outcomes following Medical Emergency Team (MET) activation	Entire hospital (excluding emergency areas, and those who were not in-patients)	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern	Retrospective analysis of MET calls over a 12-month period. 713 MET calls to 559 patients made. Three most common reasons for calling MET were GCS>2 (n=155), systolic BP <90mmHg (n=142) and respiratory rate >35 (n=109). 'Worried' accounted for 12% (n=83) of MET calls. 252 patients admitted to ICU. Most common criterion associated with admission to ICU was respiratory rate >35 (n=42).
ID 24, Salamonson et al. (2001), Australia Level of evidence: **(III)**	To determine whether the introduction of a MET team changed the pattern of ICU transfers from wards and improved hospital survival rates	All wards, critical care areas, emergency dept, and theatres.	Single parameter system Parameters (9): Heart rate, respiratory rate, blood pressure, O_2 saturation, consciousness, concern, airway threatened, repeated/prolonged seizures, respiratory arrest	Three year review of MET calls and unanticipated ICU transfers. MET team implementated at start of year one, study has no 'before' data for comparison. Frequency of calls for cardiac arrest remained constant, but the percentage of total calls to the MET for arrest fell over the 3-year study period. A small (and non-significant) decrease in the percentage of hospital deaths was seen from year 1 to year 3.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 26, Dodek et al. (2000), Canada Level of evidence: **(III)**	To determine whether timeliness of care would improve following introduction of a team approach in trauma management	Emergency department	Single parameter system. Parameters (15): Heart rate, respiratory rate, blood pressure, concern, and 11 trauma-specific criteria.	Before and after study assessing the impact of the introduction of a trauma team on elapsed time from assessment in the emergency dept (ED) to arrival of the trauma surgeon, discharge from ED, and arrival of patient in operating room (for urgent or emergent surgery). After implementation of the team, median elapsed time from assessment to arrival in operating room decreased (p=0.05), but there were no significant differences in any other measures of timeliness, crude mortality or adjusted mortality.
ID 30, Lee et al. (1998), Australia Level of evidence: **(III)**	To examine risk factors of early post-operative emergencies that required medical emergency team intervention	Surgical patients	Single parameter system. Parameters (8): Heart rate, respiratory rate, blood pressure, consciousness, threatened airway, cardiac arrest, pulmonary arrest, repeated/prolonged seizures.	Case-control study (34 cases, 126 controls) comparing incidence of post-operative emergencies (within 48hrs). Major physiological changes for MET were hypotension and decreased consciousness. High ASA status and surgery performed out of normal working hours were significant predictors of emergencies.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 4, Sharpley et al. (2004), UK. Level of evidence: *Not able to be assessed by current checklist.*	Describe the introduction of an early warning scoring system (EWSS)	Surgical unit of a district general hospital	Combination system. Includes aggregate score, also triggers if maximum score on any individual parameter. Parameters (6): Heart rate, respiratory rate, blood pressure, temperature, urine, consciousness. Graded response: ward nurses first line treatment, reviewed by ward doctor, senior medical staff, call critical care outreach nurse.	Describes the approach used to introduce the EWSS to a general mixed surgical ward, including training ward nurses to use the scoring system, and a survey of nursing staff. EWSS well received, some clarification requested on scoring items on urine output and systolic BP. Implementation assisted by multidisciplinary support, and collaboration between acute ward and critical care staff.
ID 8 Cioffi (2000), Australia Level of evidence: *Not able to be assessed by current checklist.*	To describe patient characteristics and nurses' recognition process of patients who require emergency assistance.	32 registered nurses interviewed. Setting not reported.	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern.	Study aimed to explore nurses' perceptions of patients considered to meet the MET criterion "seriously worried about". Four patient characteristics identified: feeling 'not right', colour, agitation, observations marginally changed or not at all. Subjective evaluation based on touching, observing, listening, feeling, and "knowing". Nurses relied heavily on past experiences and knowledge to detect differences in patient condition.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 9, Hillman et al. (2003), Australia Level of evidence: *Not able to be assessed by current checklist.*	To provide an overview of the challenges for health services research into medical emergency teams	Entire hospital (including all wards, critical care areas and recovery).	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern	Research into critical care has predominantly been around the evaluation of drugs or procedures. Evaluation of MET teams involves implementing changes in health service delivery and cuts across geographical, functional and professional silos. Evaluation of the MET team involved evaluating validity of calling criteria, identifying antecedents to serious events, and studying the impact on the institution and outcomes. Also describes a cluster-RCT being developed to evaluate the effectiveness of METs.
ID 11, Day (2003), UK Level of evidence: *Not able to be assessed by current checklist.*	Audit of doctors response times to calls for assistance triggered by use of the Derby Modified Early Warning System (DMEWS)	Step down unit (SDU), for higher risk surgical patients, who do not fulfil ICU admission criteria.	Aggregate scoring system: Parameters (6): Heart rate, respiratory rate, blood pressure, temperature, urine, consciousness. If score>4, advice should be sought immediately from SHO or registrar, who should review the patient within 30 min.	45 calls for medical evaluation were made over the 2-month study period. Doctors were more likely to respond faster, and within the maximum response time if the call was received from a member of the Critical Care Outreach Team, than if the call came from a ward nurse.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 15. Carberry (2002), UK. Level of evidence: *Not able to be assessed by current checklist.*	To outline experiences of implementing a modified early warning system (MEWS) and the results of a one-week pilot study.	Five surgical wards in three acute hospitals	Aggregate scoring system: Parameters (6): Heart rate, respiratory rate, blood pressure, temperature, urine, consciousness. Score of ≥4 indicates that patient should be reviewed by medical staff urgently, within 10 min if possible.	Describes the development of the scoring system, teaching sessions for staff using the tool, and secondment of a critical care nurse to support ward staff. Concludes that the MEWS is a simple scoring system that can be easily adapted and implemented to identify clinical deterioration.
ID 16, Sterling and Groba (2002), UK. Level of evidence: *Not able to be assessed by current checklist.*	Audit of the Lewisham patient-at-risk trigger scoring system (PAR-T).	Five acute wards in a teaching hospital	Aggregate scoring system: Parameters (8): Heart rate, respiratory rate, blood pressure, temperature, urine, O_2 saturation, consciousness, pain. Score >5 indicates that senior medical/surgical staff should review patient.	70 of 619 admissions triggered the warning system over the 2 month study period, 16% of whom were transferred to HDU or ICU. 14 patients were admitted to ICU during study period, all had scores >5 prior to admission. Audit of random sample of 55 observation charts found that 40% of observation had missing parameters or PAR-T score. Medical patients triggered most frequently, particularly those with chronic disease (cause of some negative feedback from ward staff).

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 20, Fox and Rivers (2001), UK Level of evidence: *Not able to be assessed by current checklist.*	To describe the introduction of a critical care outreach team	Surgical and orthopaedic wards	Aggregate scoring system Parameters (6), Heart rate, respiratory rate, blood pressure, temperature, urine, consciousness	Describes the initial implementation of a new critical care outreach team on surgical and orthopaedic wards. The team is multidisciplinary, but the nurses will rotate back to HDU/ICU enabling them to keep their critical care skills up to date. Scoring tool used has been modified from MEWS. In the first months of the team's operation, there has been a reduction in the incidence of cardiac arrests.
ID 23, Hillman et al. (2001), Australia Level of evidence: *Not able to be assessed by current checklist.*	Describe the concept of the medical emergency team, for cardiopulmonary resuscitation.	Entire hospital	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern	Most patients have identifiable deterioration prior to cardiac arrest. General wards of acute hospitals have been identified as particularly dangerous areas where cardiac arrest and CPR are associated with poor outcomes. Ward staff may lack the relevant skills and knowledge in critical care. MET team replaced the cardiac arrest team, and was based on a trauma system model, where the team is called to patients based on criteria. The MET teams scope of resuscitation is broader than simply CPR.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 28, Crispin and Daffurn (1998), Australia Level of evidence: *Not able to be assessed by current checklist.*	To assess the responses of nurses in the presence of clinical antecedents (MET criteria) to acute severe illness	Entire hospital	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern.	Retrospective review of medical records of 178 patients who required MET assistance. MET calls occurred in general wards (50%), emergency dept (42.3%), and other areas (7.7%). Four main categories of emergency were cardiac arrest (25.6%), airway/breathing problems (22%0, decreased consciousness (20.8%). A common initial response in ward areas was to call junior medical staff, which sometimes prolonged initiation to treatment.
ID 29 Daly et al. (1998), Australia Level of evidence: *Not able to be assessed by current checklist.*	To describe the application of a MET to a general hospital	Entire hospital (except theatre, recovery and emergency dept).	Single parameter system. Parameters (6): Blood pressure, consciousness, active seizures, cardiac chest pain, cardiopulmonary arrest, severe respiratory arrest. MET activated when there is a perceived imminent life-threatening problem. Upon activation, orderly takes resuscitation equipment to ward site.	68 MET calls were made for 63 patients over 12-month period. 48% occurred between 08.00 – 18.00 hours. Most common conditions leading to MET activations were chest pain(19.1%), cardiopulmonary arrest (14.7%), seizures (14.7%) and respiratory distress (13.2%). Audit of the MET activations identified six (9%) cases of late activation, and nine (13%) cases judged retrospectively to be non-life threatening.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 31, Sugrue et al. (1995), Australia Level of evidence: *Not able to be assessed by current checklist.*	To assess the performance of trauma team leaders in trauma patient resuscitations	Emergency department	Single parameter system. Parameters (20): Heart rate, blood pressure, consciousness, and 17 trauma-specific criteria	50 consecutive trauma resuscitations were assessed over a two-month period. Medical tasks were uniformly performed well by trauma team leaders. Some deficiencies in communication and delegation were observed.
ID 32, Hartin et al. (2002), UK Level of evidence: *Not able to be assessed by current checklist.*	To describe the patient emergency response team (PERT) algorithm	Not reported	Single parameter system. Parameters (8): heart rate, respiratory rate, blood pressure, urine, O_2 saturation, consciousness, concern, repeated hypoglycaemia. First responder is the PERT nurse who assesses the patient and determines the level of intervention required.	Algorithms to support the PERT nurse have been drawn up, which refer directly to the call criteria or are specific to potential causes of the problems identified. Paper describes an algorithm drawn up to support the PERT nurse when assessing a patient with a heart rate > 125.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 33, Hillman et al. (1996), Australia Level of evidence: *Not able to be assessed by current checklist.*	To identify the incidence of clinical criteria that are antecedents of cardiac arrest	General wards	Single parameter system. Parameters (4): Heart rate, respiratory rate, blood pressure, consciousness	Medical records for 5 randomly selected 24hr periods were reviewed to identify signs known to be antecedents to cardiac arrest. Data collected included age, sex, admission category, and presence of abnormal physiological variables. Nine patients (of 1027 cases reviewed) had abnormal physiology. Tachypnoea and hypotension were the most common physiological indicators.
ID 34, Hourihan et al. (1995), Australia Level of evidence: *Not able to be assessed by current checklist.*	To describe the use of a medical emergency team (MET) following the introduction of standardised calling criteria.	Entire hospital	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern.	Data collected on all MET calls over a six-month period. 294 calls made, from wards (53%), Emergency dept (31%), critical care areas (13%). Cardiorespiratory arrest accounted for 24% of calls, 60% resulted from evidence of abnormal physiological values. Decreased level of consciousness was one of the main alerting signs, followed by hypotension.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 35, Goldhill (2000), UK Level of evidence: *Not able to be assessed by current checklist.*	To provide an overview of medical emergency teams	All wards	Multiple parameter system. Parameters (7): Heart rate, respiratory rate, blood pressure, urine, O_2 saturation, consciousness, concern Senior ward nurse contacts patients doctor if the patient triggers. If immediate management does not improve the patients condition, contacting the team should be considered	Most arrests on the wards are preceded by physiological deterioration. Patients who arrest in hospital outside of critical areas have poorer outcomes. Early recognition improves outcomes. Gives an overview of the Patient at risk team (PART) used at the Royal London Hospital. An early warning score, based on physiological abnormalities is used for the identification of critically ill ward patients. Experiences with PART suggest that early intervention decreases the number of ward arrests and is likely to decrease mortality.
ID 36, Welch (2000), UK Level of evidence: *Not able to be assessed by current checklist.*	To outline how nurses can identify patients at risk of critical illness	Not reported	Aggregate scoring system. Parameters (8): Heart rate, respiratory rate, blood pressure, temperature, urine, O_2 saturation, consciousness, pain.	Not a scoring tool. Provides an overview of useful physiological indicators that might cause concern, and gives an overview of research in the area.

5.4.2 Topic 1 References

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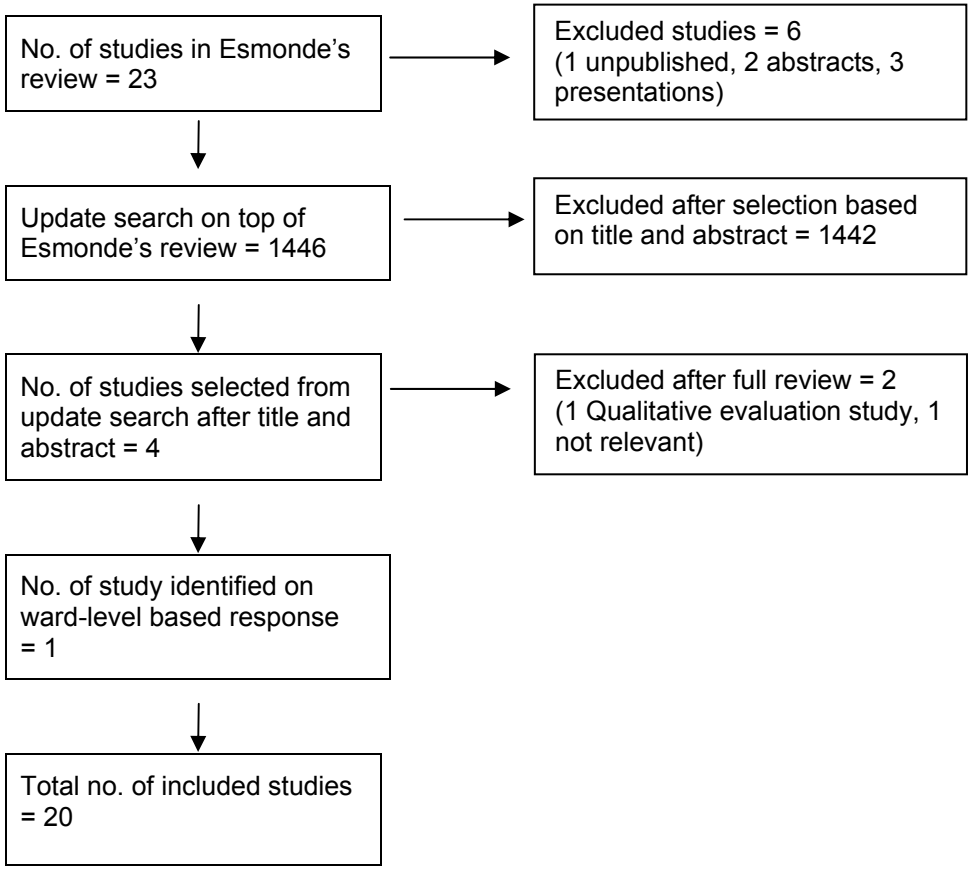
5.4.3 Topic 2: Response strategies for patients identified as having a deteriorating clinical condition

Volume of Evidence



Type of study

Total no. of studies = 20	Cluster RCT = 2 Observational study = 16 (uncontrolled before-and-after) Service evaluation = 1 Ward-level based response study (uncontrolled before-and-after) = 1

Acutely Ill Patient

Topic 2: Response strategies for patients identified as having a deteriorating clinical condition.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
154 Hillman et al. (2005) MERIT; Intro of the Medical Emergency Team (MET) system: a cluster-RCT.	Cluster RCT	1+	Total no. of hospital = 23 I = 12 C = 11 Inclusion: Public hospital with 20,000 estimated admissions/yr, with an ICU & emergency department, did not already have a MET. Covered: Patients > 14 of age; General wards; No hospital drop-out.	Patient characteristics were only assessed during 2-month baseline prior to study period. At baseline: (C Group) N = 11 *[8 teaching hospitals; 9 metropolitan based]* Mean age = 56.9 ; SD (20.8) Male = 47% Female = 53% (I Group) N = 12 [*9 teaching*	1) Education to staff (over 4 month period prior to introduction of MET) using lectures, MET videotape and books. It included: identification of patients at risks, the use of calling criteria, the need to call quickly if criteria were met & how to call MET. 2) Implementation of MET. Composition of MET varied. It	Control hospitals: 1) No MET 2) operation of existing CAT to continue 3) No educational intervention	6-month study period (pre-study: 2-month baseline & 4-month implementation period)	Primary outcome: Composite incidence of cardiac arrest, unplanned ICU admission (without NFR) & unexpected death (without NFR) Secondary outcomes: Cardiac arrest;	*per 1000 admissions:* C = 5.86 I = 5.31 Difference = -0.264 (-2.449 to 1.921) Adj p = 0.640 Adj OR = 0.98 (95% CI: 0.83-1.16) *per 1000 admissions:* C = 1.64 I = 1.31 Difference = -0.208 (-0.620 to 0.204) Adj p = 0.736 Adj OR = 0.94 (95% CI: 0.79-1.13)	Australian National Health; MRC; Australian Council for Quality & Safety in Healthcare; Australian & New Zealand Intensive Care Foundation	A well conducted study addressing a focused question with an appropriate design. A negative result, however, as far as primary outcome concerned. Process variables showed a significant difference. There was a significantly greater incidence of calling out the MET in intervention group. *Potential biases:* Setting – the inclusion of coronary care units & HDU that was not under the supervision of an intensivist as "general wards" (quality of care likely to be higher)

			No. of total patients not reported for the study phase but only assessed during 2-month baseline: **(C Group)** Total patients = 56756 **(I Group)** Total patients = 68376 <u>Setting:</u> Australian Public Health System.	*hospitals; 9 metropolitan based]* Mean age = 55.4 ; SD (19.9) Male = 50% Female = 50%	was required to be at least the equivalent of the pre-existing cardiac arrest team (CAT) & to consist of at least 1 doctor & 1 nurse from emergency department or ICU.			Unplanned ICU admission (without NFR); Unexpected death (without NFR) <u>Primary outcome during baseline, study period and combined baseline & study period:</u>	C = 4.68 I = 4.19 Difference = -0.135 (-2.330 to 2.060) Adj p = 0.599 Adj OR = 1.04 (95% CI: 0.89-1.21) C = 1.18 I = 1.06 Difference = -0.093 (-0.423 to 0.237) Adj p = 0.752 Adj OR = 1.03 (95% CI: 0.84-1.28) <u>*per 1000 admissions:*</u> C baseline = 7.07 C study = 5.86 Difference = -1.41 p = 0.030 I baseline = 6.58 I study = 5.31 Difference = -0.39 p = 0.612 C+I baseline = 6.82 C+I study =		Variability of intervention delivered by unit - composition of MET varied from setting to setting (although standardised calling criteria). - likely variability of implementation strategy as MET is a complex intervention. Possible contamination of control group. Hospital safety and MET system were highlighted and reported in the media during the study period. Could minimize differences between groups. Whether CATs & ICU staff act as informal METs in control hospitals is Unknown. <u>*Potential type 2 error:*</u> Sample size calculation appears to be inadequate (lower incidence of adverse events in control arm & higher intrahospital variability and ICC). Wide confidence interval on adverse event rate. Could explain negative finding. 6-month study period might not be long enough

									5.57 Difference = 0.089		to detect effects on outcomes.
								<u>Process measures</u>:	<u>*per 1000 admissions:*</u>		
								Calling rate of MET/CAT	C = 3.1 (1.3 SD) I = 8.7 (3.5 SD) P=0.0001		
								Mean number of calls not associated with an event	C=1.2 (0.8SD) I=6.3 (2.4SD) P<0.0001		
								Number of calls not associated with an event (% of total calls)	C=194/528 (37%) I=1329/1886 (70%) P<0.0001		
								Documentation of MET criteria			

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
3 Priestley et al. (2004) Introducing critical care outreach: a ward randomised trial of phased introduction in a general hospital.	Cluster-RCT with phased introduction **Randomised at ward level (dataset 2)* **Embedded within the study were two observational analyses:* *a) all patients (dataset 1);* *b) before and after analysis (dataset 3).* *These*	1+	Total no. of patients eligible for primary comparison = 2903 Mortality: C = 1336 I = 1456 Length of stay: C = 1291 I = 1442 Inclusion: All patients admitted to the 16 acute adult wards over a 32-week period. Setting: 800 bed acute general hospital in the north of England (UK). 16 study wards (average 30 beds each): 8 surgical; 5 medical and 3 medicine for the elderly	(C Groups): Mean age = 57.4 (95% CI: 56.3-58.5) Male = 43.1% Female = 56.9% SAPS II mean = 17.3 (95% CI: 16.8-17.8) (C Groups): Mean age = 65.2 (95% CI: 64.3-66.2) Male = 54.7% Female = 45.3% SAPS II mean = 19.9 (95% CI: 19.4-20.3)	1) Introduction of the intervention (CCOT) was preceded with a 4 week training period by the CCOT for nurses and doctors. Involved: **formal & informal sessions on the use of an "in-house" PAR 'patient-at-risk' score as calling criteria.* 2) Implementation of CCOT. Composition of CCOT: 24-hour services with 1 nurse consultant & a team of experience nurses. Interventions by CCOT: Ward staff used PAR to trigger referral to CCOT and involvement of the admitting	1) No educational intervention 2) No CCOT Very limited description of care provided on control wards	32-week study	In-hospital mortality (logistic regression) Length of stay in hospital (Cox regression)	Primary analysis: Matched-randomised: (Cluster level) OR 0.523 (95% CI: 0.322-0.849) Matched-randomised: Hazard ratio = 0.907 (95% CI: 0.835-0.985) Allowance for clustering considered likely to render this finding non-significant. *Secondary analysis:* 1) Mortality: datasets 1 & 3 both showed a reduction in mortality in patients in the intervention wards. 2) Length of stay: Dataset 1 showed intervention	York Research Innovation Fund (York Hospitals NHS Trusts)	A reasonably well conducted study addressing a focused clinical question. Chief findings: 1) A significant reduction in mortality in patients in the intervention wards 2) Possible increased length of stay for patients in the intervention wards. *Potential biases:* This is a pragmatic design. Randomisation was at ward level within a single hospital rather than at hospital level. Likely to increase risk of contamination between groups (although likely to reduce effect size) Due to the design of sequential introduction of intervention, there was no standardised intervention period: the intervention periods of different wards ranged from 4 weeks to 28 weeks. No concealment of allocation or blinding of either participants or investigators.

	are treated as second ary analyse s and reporte d only briefly here.				team's consultant. Score a 'guide', CCOT to be called if concern about patient, irrespective of PAR score. Level of CCOT involvement determined by ward staff & admitting team. As circumstances required, CCOT might support and advise ward staff, remain with the patient and provide individual nursing care on the ward during crisis period, or facilitate the admission to ICU. Emphasis on 'sharing skills'.				increased patients' mean LOS; dataset 3 reduced patients' mean LOS.		CCOT collected much of the data. There was no appropriate baseline measure. Possible 'Hawthorne effects'. *Potential confounders:* Observational data used for secondary analysis likely to exhibit this. <u>*Potential Type I error:*</u> Matched-randomised analysis resulted in a greater estimated advantage in mortality but a 20% wider CI. Unclear to what extent clustering has been accounted for in prior power calculation. A cluster-RCT with high statistical validity would have required participation of a very large number of hospitals. Generalisability: - both patient group and use of acute general hospital make study participants typical of patients in the NHS

											- 'trigger' system used is a multiple parameter system (PAR) widely used in the NHS - Only one hospital site used

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
25 Bristow et al. (2000) Rates of in-hospital arrests, deaths & intensive care admissions: the effect of a MET.	Observational study (after case-mix adjustment) *Stepwise multivariate analysis was used to model the probability of an event occurring, adjuste*	2-	Total no. of hospitals = 3 (1 intervention, 2 controls) <u>No. of admission:</u> I = 18338 C1 = 13059 C2 = 19545 <u>Inclusion:</u> All patients (age ≥ 14) admitted to 3 Australian public hospitals from 08/07/1996 to 31/12/1996. <u>Setting:</u> All 3 hospitals were similarly sized	Characteristics of admissions: *(I hospital)* Male admissions = 44.9% Female admissions = 55.1% Age distribution: 14-24 = 9.7% 25-34 = 14.9% 34-44 = 14.3% 45-54 = 12.4% 55-64 = 18.1% 65-74 = 20.5% ≥75 = 10.0% *(C1 hospital)* Male admissions = 42.9% Female	1) An education programme explained the MET's role was given to all staff. The length of educational period not reported. 2) Implementation of MET. However, calling the MET when criteria were met was not compulsory. *MET triggered by standardised calling system. A Single Parameter*	2 control hospitals: 1) No educational programme 2) No MET 3) Operation of existing cardiac arrest team (CAT) to continue. CAT was paged for cardiorespiratory arrest.	6-month	1) Case-mix adjusted rates of cardiac arrest 2) Case-mix adjusted rates of hospital mortality	I = 69 (crude rate: 38/10000) Adj OR = 1 C1 = 66 (crude rate: 51/10000) Adj OR = 1.14 (95% CI: 0.81-1.61) *[not significant]* C2 = 99 (crude rate: 51/10000) Adj OR = 1.00 (95% CI: 0.73-1.37) *[not significant*] I = 243 (crude rate: 133/10000) Adj OR = 1 C1 = 240 (crude rate: 184/10000)	Commonwealth Department of Health & Family Services Research & Development Grant.	A reasonably well conducted quasi-experimental study with case-mix adjustment that addresses a focused question. <u>Findings:</u> There are significant reductions in unanticipated admissions to ICU/HDU in both comparisons (I vs. C1 & I vs. C2). No significant differences in the rates of cardiac arrest, hospital mortality and non-DNR mortality. <u>Methodology:</u> This is an uncontrolled study, there is no proper matching of cases and controls.

	d for patient demographics & diagnostic characteristics.		Australian public hospitals with bed capacities in the range of 380-530. MET was introduced with education programme to the intervention hospital while the 2 control hospitals have cardiac arrest team.	admissions = 57.1% Age distribution: 14-24 = 8.6% 25-34 = 15.2% 34-44 = 9.6% 45-54 = 9.8% 55-64 = 18.5% 65-74 = 22.2% ≥75 = 16.0% *(C1 hospital)* Male admissions = 42.8% Female admissions = 57.2% Age distribution: 14-24 = 7.8% 25-34 = 13.1% 34-44 = 11.1% 45-54 = 10.4% 55-64 = 14.4% 65-74 = 22.1% ≥75 = 21.1%	*'trigger' system* <u>Composition of MET:</u> 1 ICU registrar, 1 senior nurse & a medical registrar. <u>Interventions by MET:</u> Not stated.	<u>Composition of CAT:</u> 1 ICU registrar, 1 ICU or coronary care nurse & a medical registrar.		3) Case-mix adjusted rates of Non-DNR mortality 4) Case-mix adjusted rates of unanticipated admission to ICU/HDU	Adj OR = 1.08 (95% CI: 0.89-1.30) *[not significant]* C2 = 295 (crude rate: 151/10000) Adj OR = 0.83 (95% CI: 0.70-1.00) *[not significant]* I = 55 (crude rate: 30/10000) Adj OR = 1 C1 = 86 (crude rate: 66/10000) Adj OR = 1.68 (95% CI: 1.19-2.36) *[not significant]* C2 = 88 (crude rate: 45/10000) Adj OR = 0.94 (95% CI: 0.67-1.33) *[not significant*] I = 118 (crude rate: 64/10000) Adj OR = 1 C1 = 146 (crude rate: 112/10000) Adj OR = 1.59 (95% CI: 1.24-		The limitation of case-mix adjustment methodology:- multiple methods of case-mix adjustment are possible and these may give divergent results. <u>Potential confounding factors:</u> No special efforts regarding staff education in the study period were made. Lack of education might contribute to less MET calls (MET calls of this study is low compared to other studies). This might contribute to the non-significant findings. Calling for MET was not compulsory when criteria were met. This might also contribute to the non-significant findings. *<u>Generalisability:</u>* This is an Australian study of 3 hospitals with single parameter TT system, which is very different from most UK hospitals.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
								*Odd ratios were adjusted for patient characteristics and diagnostic categories.	2.04) *[significant reduction]* C2 = 234 (crude rate: 120/10000) Adj OR = 1.73 (95% CI: 1.37-2.16) *[significant reduction]*		

1022 Goldhill et al. (1999) The PART: identifying & managing seriously ill patients.	Observational study	2-	Total no. of patients not reported. *N*s were reported as No. of admissions. Total no. of admissions = 97 Admissions seen by PART (I) = 28 Admission not seen by PART (C) = 69 <u>Inclusion:</u> Not clear. Presume all hospital wards. <u>Setting:</u> Single hospital – Royal London Hospital.	<u>(I Group):</u> Mean age = 55 (SD: 21.1) Male = 54% Female = 46% Previous ICU = 29% Median pre-ICU APACHE II = 14 (IQR: 11-20) <u>(C Group):</u> Mean age = 53 (SD: 17.8) Male = 54% Female = 46% Previous ICU admission = 17% Median pre-ICU APACHE II = 16 (IQR: 9-20)	1) PART protocol (multiple parameter) was introduced onto all wards. Laminated copies of the protocol were placed on the ward notice boards & information about PART was circulated to nurses & doctors within the hospital. 2) ICU admissions seen by PART within 48 hours of admission. <u>Composition of PART:</u> Consists of 1 ICU consultant or deputy, 1 senior ICU nurse & the duty medical or surgical registrar as appropriate. <u>Interventions by PART:</u> Patients were transferred	1) PART protocol was introduced onto all wards. Laminated copies of the protocol were placed on the ward notice boards & information about PART was circulated to nurses & doctors within the hospital. 2) ICU admissions NOT seen by PART.	6-month study	1) ICU mortality (No. & %) 2) Hospital length of stay before ICU admission (median: days) 2) ICU length of stay (median: days) 3) No. of CPR in acute wards before ICU admission (No. & %)	I = 7 (25%) C = 31 (44.9%) *p = 0.07 (NS)* I = 5.5 (IQR: 1-17.5) C = 6 (IQR: 1-16) **p-value not reported* I = 5.5 (IQR: 1-9.25) C = 2 (IQR: 1-6) **p-value not reported* I = 1 (3.6%) C = 21 (30.4%) *p < 0.005*	Not reported.	An observational study looks at both identification of 'at risk' patients and an intervention (management by PART team). Only the CPR rate has significant results suggesting that PART appeared to be successful in preventing the need for CPR. (CI not reported). *<u>Potential biases/confounding factors:</u>* This study has a number of biases. In particular, there is no proper matching of cases and controls. Informal education/training for staff. The author has suggested that despite the availability of PART, the majority of patients were not assessed before admission to ICU and there is possibility that some doctors and nurses were unaware of the system. At assessment, many patients were already monitored and treated with high quality of care (eg: the use of oximetry, oxygen supply, ECG, etc.)

					directly to ICU. If patient remained on the ward, PART would advise on management (primarily in the management of respiratory problems & hypovolaemia) & decide whether regular review was necessary. <u>Protocol of review by PART:</u> - Admit immediately - Within 4-hour - After 4-hour - DNR						Some patients the PART would like to have admitted were managed on the ward because of lack of ICU beds. <u>*Generalisability:*</u> This is a single hospital study with unusually high number of emergency, trauma & seriously ill patients.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
24 Salamonson et al. (2001) The evolutionary process of MET implementation: reduction in unanticipated ICU transfer.	Observational study	2-	Total no. of patients not reported. *N*s were reported as No. of MET ICU transfers *(I)* & No. of unanticipated ICU transfer *(C)* over 3 years period. Total ICU transfers = 240 I = 100 C = 140 <u>Inclusion:</u> Not clear. Presume all hospital wards. <u>Setting:</u> Single hospital - A suburban non-teaching metropolitan hospital in Australia (200-bed).	Patient characteristics for I group not reported. <u>Patient characteristics for C group:</u> *Mean age = 61.6 (range: 9-90 years)* *Female = 52%* *Male = 48%* *Patient characteristics for all 299 MET calls over 3 years: mean age = 60.5 (range: 0-97years) Female = 51% Male = 49%	1) Formal training in all aspects of advanced resuscitation. 2) The utilisation of MET by staff which resulted in ICU transfers. *MET triggered by standardised calling system. A Single Parameter 'trigger' system* <u>Composition of MET:</u> 24-hour system consists of 1 physician, 1 nursing staff from ICU/CCU, 1 registrar from emergency department, 2 non-clinical staff. <u>Interventions by MET:</u> Bag-mask ventilation, Endotrachael intubation, Cardiac massage, Cardiac defibrillation.	1) Formal training in all aspects of advanced resuscitation. 2) Unanticipated ICU transfers without the utilisation of MET by staff.	3 years.	In-hospital mortality <u>Process measures:</u> 1) No. of MET calls 2) Reduction in unanticipated ICU transfers	<u>Year 1:</u> I = 17 (71%) C = 44 (76%) <u>Year 2:</u> I = 27 (79%) C = 35 (76%) <u>Year 3:</u> I = 31 (74%) C = 26 (72%) *Differences between I and C are not significant, but p-values not reported. Year 1 = 54 Year 2 = 115 Year 3 = 130 *No analysis on differences Yr 1 = 58 (71%) Yr 2 = 46 (58%) Yr 3 = 36 (46%) $X^2 = 9.969$, df = 2, p = 0.007	Not reported.	Study design difficult to determine. Study addresses a focused question. The results are not significant (p-value and CI not reported). Process variables showed a trend of increased MET calls with decreased unanticipated ICU transfers. However, the reduction in unanticipated ICU transfers over the study period was likely a factor of increase MET ICU transfers. The demand for ICU beds with the implementation of MET system remained fairly constant. The author also suggested that the MET system being called increasingly for less acute patients. <u>*Potential biases/confounding factors:*</u> This study has significant biases. In particular, there is no proper matching of cases and controls. It is not known if the intervention group differs from the control group in terms of demographic details & type of illness or illness severity.

											It is not known if time trends are taken into account. Training was provided to all staff. The utilisation of MET was influenced by staff's subjectivity. For example, the author has suggested that some ward staff were still opting not to use the MET system for patients who fulfilled the predetermined MET calling criteria. This is a single hospital study, issue on generalisability. There is no clear inclusion/exclusion criteria. Information on severity of illness was not collected.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
10 Bellomo et al. (2003) A prospective before-and-after trial of a MET.	Observational study, uncontrolled before & after study	2-	Total no. of consecutive patients admitted to hospital = 42011 *(C group) Pre-MET = 21090* *(I group) Post-MET = 20921* <u>Inclusion:</u> Consecutive patients admitted to hospital during 4-month pre-period (May-Aug 1999) and during 4-month post- period (Nov 2000-Feb 2001). <u>Setting:</u> Single hospital (teaching hospital) – Austin & Repatriation Medical Centre, Australia.	*Patient characteristics of the 85 cardiac arrest cases and the 42011 consecutive patients were not provided.*	1) 1 year preparation & education period to introduce the MET. Extensive and repeated presentations and discussions were held with all members of the medical, nursing & paramedical staff. 2) Implementation with 2-month 'run-in' period. 3) Intervention period (data collected over 4 months) *MET triggered by standardised calling system. A Single Parameter 'trigger' system* <u>Composition of MET:</u> The duty intensive care fellow & a designated intensive care	A 4-month 'pre-MET' period 1) No preparation nor education on MET. *<u>Seasonal control:</u> Data was also collected at the same seasonal period as the intervention period 2 years ago (Nov 98 – Feb 99)*	Total study period = 8 months *Pre-MET = 4-month* *Post-MET = 4-month*	<u>Primary outcome:</u> No. of cardiac arrest. <u>Other outcomes:</u> 1) Mortality from cardiac arrest 2) LOS in ICU after cardiac arrest (days) 3) LOS in hospital after cardiac arrest (days)	C = 63 I = 22 Diff = 41 (95% CI: 23-59) RRR = 0.35 (95% CI: 0.22-0.57) p < 0.001 C = 37 I = 16 Diff = 21 (95% CI: 7-35) RRR = 0.43 (95% CI: 0.26-0.70) p = 0.005 C = 163 I = 33 Diff = 130 (95% CI: 110-150) RRR = 0.20 (95% CI: 0.13-0.33) p < 0.001 C = 1353 I = 159 Diff = 1194 (95% CI: 1119-1269) RRR = 0.11 (95% CI: 0.09-0.13) p < 0.001	Quality Improvement Branch of the Acute Health Care section of the Victorian Department of Human Services, Australia.	A prospective uncontrolled before & after study with appropriate seasonal control design that addresses a focused question. <u>Findings:</u> Positive results for both primary outcome (cardiac arrest and other outcomes (mortality from cardiac arrest, hospital & ICU LOS after cardiac arrest and inpatient mortality). *<u>Potential biases/confounding factors:</u>* This is not a RCT nor Quasi-experiment, the study has significant biases. In particular, there is no proper matching of cases and controls. Positive findings may have been due to high cardiac arrest rates in the control period or an abnormally low seasonal incidence in the intervention period compared to Australia national average. A possible seasonal bias against the MET: the 4-month post-MET period was parallel to the 3-month immediately after the start of new interns.

					nurse (also the receiving medical registrar if available and the ICU consultant if requested). <u>Interventions:</u> A total of 27 types of interventions were carried out by the MET. Interventions that were most carried out: Nasopharyngeal/ oropharyngeal suctioning & additional oxygen; Administration of IV fluid bolus; Administration of IV frusemide bolus; Initiation of non-invasive positive pressure ventilation by mask; Nebulised salbutamol. *<u>*Timing of response:</u>* *- MET attended each call within a mean (SD)*			4) Inpatient mortality	C = 302 I = 222 Diff = 80 (95% CI: 37-123) RRR = 0.74 (95% CI: 0.70-0.79) p = 0.004 *<u>*Seasonal control period:</u>* *All results comparisons of pre-MET vs. seasonal control are non-significant.* *All results comparisons of post-MET vs. seasonal control are significant.*		The positive results could be associated to the highly skilled MET that carried out extensive interventions compared to other negative studies with less skilled team? <u>*Generalisability:*</u> This is a single hospital study in Australia with single parameter TT system, which is very different from most UK hospitals.

					period of 4.5 mins (2.2). *- MET was in attendance for a mean (SD) period of 19 mins (18).*						
ID 6 Bellomo et al. (2004) Prospective controlled trial of effect of MET on post-operative morbidity and mortality rates. ***Note: This is the same study as above (ID 10), the authors simply published another paper analysing*	As above.	2-	Total no. of consecutive patients admitted to hospital for 'major surgery' = 2183 *(C group) Pre-MET = 1116* *(I group) Post-MET = 1067* <u>Inclusion:</u> Consecutive patients admitted to hospital for 'major surgery' during 4-month pre- period (May-Aug 1999) and during 4-month post- period (Nov 2000-Feb 2001). <u>Setting:</u>	<u>Patient characteristic of the surgical patients:</u> (C group) Age = 60.7 ±19.7 Male = 58.4% Female = 41.6% (I group) Age = 60.1 ±19.5 Male = 57.4% Female = 42.6%	As above.	As above. *BUT, no seasonal control analysis was carried out.*	As above.	1) Unplanned ICU admissions 2) Surgical mortality 3) LOS after major surgery 4) Surgical ICU readmissions	C = 89 I = 48 Relative Risk Reduction = 44.4% p = 0.001 C = 73 I = 45 Relative Risk Reduction = 36.6% p = 0.0178 C = mean 23.8 ±56.5 days I = mean 18.9 ±35.3 days p = 0.0092 C = 33/1116 (2.9%) I = 20/1067 (1.8%) *[not significant]*	As above.	A reasonably well conducted prospective uncontrolled before & after study that addresses a focused question. <u>Findings:</u> Positive results for three outcomes (unplanned ICU admissions, surgical mortality & LOS after major surgery) but not on 'surgical ICU readmissions'. <u>*Potential biases/confounding factors:*</u> See above as it's the same study. <u>*Generalisability:*</u> This is a single hospital study in Australia with single parameter TT system, which is very different from most UK hospitals.

different variables from the study (ie. focused on surgical patients)			Single hospital (teaching hospital) – Austin & Repatriation Medical Centre, Australia.								

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1023 Garcea et al. (2004) Impact of a critical care outreach team on critical care readmissions and mortality.	Observational study, Retrospective uncontrolled before & after study	2-	Total no. of patients with critical care 'readmission' = 128 C = 49 I = 79 <u>Inclusion:</u> All readmissions to critical care between July 1999 and September 2003. <u>Setting:</u> Single hospital (teaching hospital) – The Leicester General Hospital.	<u>(C Group: pre-outreach)</u> Mean age = 65.2 Male = 29 (59%) Female = 20 (41%) APACHE scores (median) = 20.1 (IQR: 5-35) <u>(I Group: post-outreach)</u> Mean age = 63.4 Male = 38 (48%) Female = 41 (52%) APACHE scores (median) = 19.1 (IQR: 6-32)	Post-outreach: 1) CCOT provided education to ward staff in assessing deteriorating patients using MEWS (aggregate scoring system). 2) Implementation of the CCOT with MEWS. *MEWS is an aggregate scoring TT system.* <u>Composition of CCOT:</u> 2 senior grade nurses, 1 consultant nurse specialist & 1 consultant intensivist as lead clinician for the team. <u>Intervention by CCOT:</u> Not stated.	Pre-outreach: 1) No education on CCOT or MEWS. 2) No implementation of CCOT.	Total study period = 51-month *Pre-outreach = 21 months* *Post-outreach = 30 months*	1) Critical care mortality in 'readmissions'. 2) 30-day critical care mortality in 'readmissions' 3) Hospital mortality amongst readmitted patients. 4) LOS on critical care following readmission. 5) LOS in-hospital following readmission.	C = 36.7% I = 22.8% (95% CI: -2.4% to 30.3%) *[not significant]* C = 53.1% I = 32.6% (95% CI: -1.4% to 33.5%) *[not significant]* C = 49.6% I = 32.6% (95% CI: 2.8% to 37.6%) *[significant]* <u>(C group):</u> mean days = 6.2 (range: 3-19 days) <u>(I group):</u> mean days = 8.3 (range: 4-17 days) **Not Significant but CI & p-value not reported.* <u>(C group):</u> mean days = 16.9 (range: 10-38 days) <u>(I group):</u> mean days = 17.1 (range: 8-34 days) **No further analysis carried*	Not reported.	<u>Findings:</u> There is a reduction in hospital mortality amongst readmitted patients, although 95% CIs are wide. There is also a reduction in critical care mortality and 30-day critical care mortality in 'readmissions' but these findings do not reach statistical significance. . <u>*Potential biases/confounding factors:*</u> This is a retrospective uncontrolled before and after study conducted over 51 months. It is difficult to exclude or control hidden biases or confounding variables retrospective study eg: there may be many other possible changes within the hospital during those 51 months on clinical practices and management that were not accounted for in this study. As the study is uncontrolled, it is not possible to allow for secular trend (e.g., a reduction in mortality over time independent of intervention). No matching cases and control and no blinding was possible in the study. Sample size is likely to be

								6) Pre- and post-readmission rates.	*out.* C = 7% I = 6% *[not significant]*		too small, with high risk of type 2 error. The 95% CIs are very wide. Due to lack of control of confounding variables, the author suggested that no causative factors can be identified from this study. The decrease in mortality rates might not be the direct result of the introduction of CCOT, it could be due to chance or other factors such as: • Changes in the administration of critical care services • Variation in the case-mix discharged from critical care • The effect of the clinical training and education itself • Introduction of appropriate intravenous fluid resuscitation, intravenous antibiotics & oxygen therapy on the ward awaiting transfer <u>*Generalisability:*</u> 1) It is a single hospital study in the UK. 2) 'TT' system used is an aggregate scoring system (MEWS) which is widely

											used in the NHS. 3) The CCOT only covered 3 surgical wards, surgical admission unit & the surgical acute care unit.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1027 Ball et al. (2003) Effect of the CCOT on patient survival to discharge from hospital and readmission to critical care: non-randomised population study.	Observational study, Retrospective uncontrolled before & after study	2-	Total no. of patients (discharged after 1st or only admission to ICU) = 570 C = 201 I = 269 <u>Inclusion:</u> Patients discharged from the critical care unit after their first or only admission for 2 study periods: 26/02/2000 to 25/02/2001 (pre-outreach) and 26/02/2001 to 25/02/2002 (post-outreach)	<u>(C Group: pre-outreach)</u> Mean age = 51.6 (95% CI: 49.1-54.1) Male = 118 (59%) Female = 83 (41%) No. with APACHE II scores = 44 (22%) Mean APACHE II scores = 16.4 (95% CI: 15.5-17.3) <u>(I Group: post-outreach)</u> Mean age = 49.6 (95% CI: 47.5-51.8) Male = 160 (59%) Female = 109 (41%) No. with	Post-outreach: 1) Implementation of the CCOT with EWS 12 hours daily. (aggregate scoring system) **Note: no mention of pre-education or training.* *MEWS is an aggregate scoring TT system.* <u>Composition of CCOT:</u> 5 senior critical acre nurses led	Pre-outreach: 1) No implementation of CCOT.	Total study period = 2 years *Pre-outreach = 1 year* *Post-outreach = 1 year*	1) Hospital mortality after ICU discharge 2) No. of readmissions to critical care	C = 162/201 (81%) I = 235/269 (87%) Risk Ratio = 1.08 (95% CI: 1.00-1.18) *[significant]* C = 25/201 (12%) I = 16/269 (6%) Risk Ratio = 0.48 (95% CI: 0.26-0.87) *[significant]*	None.	A retrospective uncontrolled before & after study with clear inclusion/exclusion criteria, checked data reliability & detailed information that attempts to address clinical questions. <u>Findings:</u> There are positive results on hospital mortality after ICU discharge (although the 95% CI includes 1.00, which raises concerns about the clinical significance of the finding) and number of readmissions to critical care. <u>*Potential biases/confounding factors:*</u> Confounding variables cannot be controlled in retrospective before and after study with historical

			Exclusion: - Patients who died in critical care. - Patients who were admitted pre-outreach but discharged in post-outreach period. - Patients who admitted pre-outreach but readmitted in post-outreach period. Setting: Single hospital (tertiary referral teaching hospital) – Royal Free Hampstead Hospital, London (has 1200 beds including 20 critical beds).	APACHE II scores = 45 (17%) Mean APACHE II scores = 16.1 (95% CI: 15.3-16.8)	by a consultant nurse, service available 12 hours daily. Interventions by CCOT: Guiding tracheostomy management; tracheal suction & chest physiotherapy; guiding management of continuous positive airway pressure; optimising patient positioning; requesting prescription or administration of nebuliser therapy; requesting repeat blood testing; increase the frequency of CVS/respiratory observations; starting hourly fluid balance monitoring; requesting samples be sent for microculture & sensitivity.						controls. As the study is uncontrolled, it is not possible to allow for secular trend (e.g., a reduction in mortality over time independent of intervention). No matching of cases and control; and no blinding was possible in the study. Author commented that: - Due to lack of control of variables, a concomitant innovation (not necessary the CCOT) in the hospital could have produced the same results. - The interventions undertaken by team members did vary depending on individuals & on a particular day. - The use of routine audit data, rather than specific data collected for research purposes, may also have produced erroneous results. *Generalisability:* 1) It is a single hospital study in the UK. 2) 'trigger' system used is a aggregate scoring

											system (EWS) which is widely used in the NHS.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1028 Leary and Ridley (2003) Impact of an outreach team on readmission to a critical care unit.	Observational study, Retrospective uncontrolled before & after study	2-	Total no. of patients with critical care 'readmission' = 100 C = 49 I = 51 <u>Inclusion:</u> All readmissions to critical care between April 2000 and November 2001. **Note: critical care = ICU + HDU* <u>Setting:</u> Single hospital (teaching hospital with 1000-bed) – Norfolk & Norwich Hospital.	<u>(C Group: pre-outreach)</u> Mean age = 62.0 (SD: 15.2) Male = 36 (74%) Female = 13 (26%) <u>(I Group: post-outreach)</u> Mean age = 62.3 (SD: 15.8) Male = 31 (61%) Female = 20 (39%)	Post-outreach: 1) Implementation of the CCOT during 'normal working hours'. **Note: no education/ training was mentioned; composition of the CCOT & intervention protocol were not reported.* **Type 'TT' system used not stated either.*	Pre-outreach: 1) No implementation of CCOT.	Total study period = 20-month *Pre-outreach = 10 months* *Post-outreach = 10 months*	1) Critical care mortality in 'readmissions'. 2) LOS 1st critical care admission (median) 3) LOS between discharge on general ward and 2nd admission (median) 4) LOS 2nd critical care admission (readmission) (median)	C = 6 (12.2%) I = 10 (19.6%) X^2 = 1.18, df = 1, p = 0.28 *[NS]* C = 1.68 (IQR: 0.69-3.18) I = 1.80 (IQR: 0.96-4.03) *[not significant*] C = 2.93 (IQR: 1.32-6.05) I = 2.25 (IQR: 1.06-6.32) *[not significant]* C = 2.68 (IQR: 0.94-5.79) I = 2.02 (IQR: 0.91-6.32) *[not significant]*	Not reported.	A poor retrospective uncontrolled study with no proper matching of cases and controls or information that attempts to address a focused question. <u>Findings:</u> All outcome measures are negative. Although the author commented that the assumed benefits of CCOT are difficult to quantify scientifically. Lack of information on the type of 'TT' system used, the composition of CCOT and what kind of intervention provided by the CCOT. *<u>Potential biases/confounding factors:</u>* This is a poorly design retrospective uncontrolled study over 20 months. Many possible

											confounding factors were not taken into account. There was no proper matching of cases and controls Sample size too small. Possible Type II error. *Generalisability:* This is a single UK hospital study but not much information was provided for generalisation.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
19 Buist et al. (2002) Effects of a MET on reduction of incidence of and mortality from unexpected cardiac arrest in	Observational study, Retrospective before & after study (adjustment for case-mix)	2-	Total no. of patients = 42164 (Pre-MET) C = 19317 (Post-MET) I = 22847 Inclusion: All patients admitted to the hospital in 1996 (pre-MET) and 1999	*(C group)* Mean age = 36.6 (SD: 26.0) Male = 44.4% Female = 55.6% Mean APACHE II score = 18.4 *(I group)* Mean age = 36.4 (SD: 26.0) Male = 44.6% Female = 55.4% Mean APACHE	1) Implementation of a formal education and audit process directed at junior medical staff and nursing staff. The process included interactive audiovisual presentations to small groups, attachment to all staff	1) No implementation of education. 2) No MET. 3) Operation of existing 'traditional' system of response.	12-month pre-MET 12-month post-MET	1) Hospital mortality 2) No. of Cardiac arrest	C = 380 (19.67/1000 patients) I = 393 (17.20/1000 patients) p < 0.001 C = 73 (3.77/1000 patients) I = 47 (2.05/1000 patients) p < 0.001	Australia, Department of Human Services	A poor retrospective uncontrolled study with no proper matching of cases and controls or information that attempts to address a focused question. Findings: There are significant reductions in hospital mortality, no. of cardiac arrest, cardiac arrest mortality and hospital LOS. However, there is no significant difference between pre-MET and

hospital: preliminary study.			(post-MET). <u>Setting:</u> A 300-bed general metropolitan teaching hospital in Australia. The hospital has over 20000 inpatients and there are 500 to 600 admissions to ICU.	II score = 18.9	identification badges of the criteria for calling the MET, and strategic placement of posters throughout the hospital. 2) Implementation of MET. *MET triggered by standardised calling system. A Single Parameter 'trigger' system* <u>Composition of MET:</u> 1 medical registrar, I intensive care registrar, 1 senior intensive care nurse. <u>Interventions by the MET:</u> The MET is equipped with resuscitation drugs, fluids and equipment.			3) Cardiac arrest mortality 4) Unplanned ICU admissions 5) Hospital LOS (mean days)	C = 56 (76.7%) I = 26 (55.3) p < 0.001 C = 45 (2.3/1000 patients) I = 78 (3.4/1000 patients) *[not significant]* C = 3.6 (SD: 6.3) I = 3.9 (SD:14.8) p < 0.001		post-MET on unplanned ICU admissions. *<u>Potential biases/confounding factors:</u>* Possible 'Hawthorne effect' as the as the research project had a high profile within the hospital. This is a multiple comparison study. This study design is prone to type 1 errors (multiple significance testing). But the use of a significance level at 0.001 might be sufficient to overcome this problem. The employment of a full time research nurse to facilitate the implementation of the system may have improved the ward management of patients with clinical instability rather the effectiveness of the MET itself. *<u>Generalisability:</u>* This is an Australian study with different 'TT' system compared to UK hospitals.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
2 DeVita et al. (2004) Use of MET responses to reduce hospital cardiopulmonary arrest.	Observational study, Retrospective before & after study **the study looked at before and after the 'increased' use of MET, NOT pre- and post-implementation*	2-	Total no. of patients = 254272 (4565 MET calls) C = 199024 (3269 MET calls) I = 55248 (1296 MET calls) <u>Inclusion:</u> All hospital admissions over 6.8 years (Before 'increased' use of MET: Jan 1996 to Dec 2000; after 'increased' use of MET: Jan 2001 to Sep 2002). <u>Setting:</u> A tertiary care university hospital complex consists of 622 beds in United	<u>Analysis from the total of 4564 MET calls:</u> Mean age = 61 Male = 52% Female = 48%	1) Implementation of MET with a protocol delineating objective criteria for when the MET should be activated (single parameter). *MET triggered by standardised calling system. A Single Parameter 'trigger' system* <u>Composition of MET:</u> 1 ICU physician & 2 ICU nurses, 1 floor nurse, 2 anesthesia or critical care physicians. <u>Interventions by MET:</u> Prepare medications, equipment, defibrillator for	2) Implementation of MET 'without' an objective calling criteria.	5 years (before 'increased' use of MET) *[control]* 1.8 years (after 'increased' use of MET) *[intervention]*	1) Mean monthly incidence of cardiopulmonary arrest 2) Cardiac arrest mortality (on day of cardiac arrest) 3) In-hospital mortality (after cardiac arrest) <u>Process:</u> No. of MET calls before and after the introduction of objective criteria (per 1000 hospital admissions)	<u>Per 1000 admissions:</u> C = 6.5 I = 5.4 p = 0.016 C = 33.3% I = 33.3% *[not significant]* C = 52.2% I = 58.9% *[not significant]* Before = 13.7 After = 25.8 p < 0.001 **However, no data on no. of ICU admissions after MET calls was provided.*	Not reported.	A poor retrospective uncontrolled study with no proper matching of cases and controls with unequal time periods trying to address some clinical questions. <u>Findings:</u> Positive result on mean monthly incidence of cardiopulmonary arrest but not on mortality (neither death on day of cardiac arrest nor in-hospital death after cardiac arrest). It is difficult to exclude or control hidden biases or confounding variables in retrospective study. <u>Methodology & analysis:</u> Big discrepancy between the 2 study periods: 5 years control vs. only 1.8 years intervention. Although mean monthly incidence was used to run analysis, the smaller number of data during intervention period may lack power to detect real differences compared with larger control data.

			States.		delivery of patients; deliver medications, obtain vital signs, verify IV function; oxygen supply, suction, assess circulation, deliver chest compressions. Obtain arterial blood for analysis, thoracostomy, central venous access.						This is a study that looked at before- and after- the introduction of an 'objective calling criteria', not pre- and post implementation of MET. Lack detailed information on statistical analysis. A minority of unidentified discharge data was imputed based on contemporaneous MET responses for which outcome data were available. *Generalisability:* This is an Australian study with different 'TT' system compared to UK hospitals.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
12 Pittard (2003) Out of our reach? Assessing the impact of introducing a critical care outreach service.	Observational study, Retrospective before & after study	2-	The study does not mention No. of patients for both control group and intervention group. The study only mentions during the 6 months post-CCOT period, there are 273 patients who were seen by the CCOT. <u>Inclusion:</u> Not clear. The study only mentions data was collected from June to November 2000 (audit pre-CCOT) and from June to November 2001 (post-CCOT) from 3 surgical wards. <u>Setting:</u> Single UK hospital – The General Infirmary,	Not provided.	1) Implementation of CCOT with MEWS (aggregate scoring system). Service available 09.00-17.00, Monday-Friday. **No pre-education was mentioned.* *MEWS is an aggregate scoring TT system.* <u>Composition of CCOT:</u> Senior critical care nurses and medical staff (exact number of staff not reported). <u>Interventions by CCOT:</u> - Avert admissions by identifying patients who are deteriorating and instituting treatment early	2) No implementation of CCOT	<u>12-month study period:</u> 6-month pre-CCOT 6-month post-CCOT	1) No. of admissions to ICU 2) Unplanned ICU admissions 3) All ICU LOS (mean) 4) LOS of unplanned ICU admissions (mean) 5) Overall ICU mortality 6) ICU mortality for unplanned admissions 7) No. of ICU readmissions (n)	C = 328 I = 297 *[not significant]* C = 58% I = 43% p = 0.05 C = 3.4 days I = 3.7 days *[not significant]* C = 7.4 days I = 4.8 days p > 0.05 *[not significant]* C = 27.8% I = 27.7% *[not significant]* C = 28.6% I = 23.5% p = 0.05 C = 15 I = 11 p = 0.05	Not reported.	A very poor retrospective uncontrolled study with no proper matching of cases and controls and no information on no. of patients. <u>Findings:</u> There are positive results on unplanned ICU admissions, ICU mortality for unplanned admissions & no. of readmissions. <u>*Potential biases/confounding factors:*</u> It is difficult to exclude or control hidden biases or confounding variables in retrospective study. No inclusion/exclusion criteria. No. of patients, no. of cases & controls and patient characteristics were not reported. The study covered the surgical high dependency unit where quality of care should be good anyway? <u>*Generalisability:*</u> This is a UK study with commonly use 'TT' system

			Leeds.		or by ensuring timely admission to an area where they can be treated to ensure the best outcome. - Support the continued recovery of previously critically ill patients discharged to the ward and after discharge from hospital. Share critical care expertise and experience.						but it only covered 3 surgical wards and the surgical high dependency unit.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
13 Subbe et al. (2003) Effect of introducing the MEWS on clinical outcomes,	Observational study, Mixed prospective & retrospective before & after study	2-	Total no. of patients = 2354 C = 659 I = 1695 <u>Inclusion/Exclusion:</u> *(I group)* All medical admissions	*(C group)* Mean age = 63 (SD: 20) Male = 45% Female = 55% *(I group)* Mean age = 64 (SD: 19) Male = 45% Female = 55%	1) All medical admissions unit nursing staff were trained by the investigators and the CCOT to collect bedside observations and to calculate MEWS.	Data from previous MEWS validation study was used as control.	I = 3-month (post-MEWS) C = 1-month (pre-MEWS, data from previous	1) Hospital mortality (n) 2) ICU mortality 3) ICU LOS	C = 53 I = 166 *[not significant]* C = 67% I = 33% p = 0.21 C = 4 (IQR: 1-8)	North-East Wales NHS Trust Research & Development Fund.	A very poor uncontrolled study with no proper matching of cases and controls. <u>Findings:</u> All results are negative or not been further analysed. <u>*Potential biases/confounding*</u>

cardio-pulmonary arrests and intensive care utilisation in acute medical admissions.	**This a study that looked at the effectiveness of MEWS with already existing CCOT.*		from 1st Feb to 31st April 2001 aged above 15 years. Patients admitted for palliative care only and patients admitted directly to other wards were excluded. *(C group)* Data from a prospective observational study (MEWS validation study) published previously was used as a control group. This control group was admitted to the same admissions unit during February 2000. <u>Setting:</u> Single hospital in Wales.		2) All medical staff caring for emergency medical admissions were briefed concerning the MEWS, its interpretation and their role in the management of a patient identified as being at risk of deterioration. The nursing staff were instructed to alert appropriate medical staff and the CCOT if MEWS was 5 or more. 3) Implementation of MEWS with CCOT. *MEWS is an aggregate scoring TT system.* <u>Composition of CCOT and Interventions by CCOT:</u> Not stated.		published study)	4) Cardiac arrest 5) ICU/HDU admission	days I = 2 (IQR: 1-30) days p = 0.3 C = 4 (0.6%) I = 40 (2.3%) *[no further analysis]* C = 27 (4%) I = 85 (5%) *[no further analysis]*		*<u>factors:</u>* The study has used data from another previous study as control group. There are unequal time periods for pre- and post-MEWS. *<u>Generalisability:</u>* This is a UK study with commonly use 'TT' system.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1025 Story et al. (2004) The effect of critical care outreach on post-operative serious adverse events.	Observational study, Mixed prospective & retrospective before & after study **A study looked at additional critical care outreach on top of MET for surgical patients.*	2-	Total no. of patient = 664 C = 319 I = 345 <u>Inclusion:</u> All surgical patients between April 2001 and April 2002 <u>Setting:</u> Single hospital with already established MET - Austin Health Hospital, Australia	*(C group)* Age > 75 = 160 (50%) Male = 152 (48%) Female = 167 (52%) Patients with comorbidities = 140 (44%) *(I group)* Age > 75 = 176 (51%) Male = 179 (52%) Female = 166 (48%) Patients with comorbidities = 162 (47%)	1) MET with additional critical care outreach (1 critical care nurse, only weekdays) <u>Composition of critical care outreach:</u> 1 critical care nurse <u>Interventions by critical care nurse:</u> Oxygen therapy, aggressive fluid management, patient education for deep breathing, acute pain service called, patient controlled analgesia education, patient specific education of nursing & medical staff, direct MET call.	1) MET with no critical care outreach	13-month study period *Pre-outreach = 5.5-month* *Post-outreach = 7.5-month*	1) 30-day surgical patient mortality	C = 29 (9.1%) I = 24 (7.0%) (95% CI: -6% to 2%) *[not significant]*	The Victoria Department of Human Services	A very poor uncontrolled study with no proper matching of cases and controls. <u>Findings:</u> Negative result on 30-day surgical patient mortality. **A study that looked at various different adverse events which are not quite fitted into this review eg: sepsis, renal impairment, myocardial infarction, pulmonary oedema, stroke, reintubation, etc.*

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1024 Norwood et al. (2004) Evaluation of the role of a specialist tracheostomy service. From critical care to outreach and beyond.	Observational study, Mixed prospective & retrospective before & after study **This study looked at the effectiveness of CCOT within the specialist tracheostomy care service.*	2-	Total no. of patient = 170 C = 51 I = 119 <u>Inclusion:</u> *(C group)* All patients receiving a tracheostomy from April 1998 to March 1999. *(I group)* All patients that had had placement of tracheostomy from April 2001 to April 2003. <u>Setting:</u> Single UK hospital with 8 ITU beds, 4 HDU beds, 4 level 1 care beds, 83 acute surgical beds & 175 acute medical beds – Leicester General Hospital.	Not reported.	1) New tracheostomy service with an ITU outreach sister. <u>Composition:</u> 1 ITU sister. <u>Interventions by outreach:</u> Not clear, only mentioned the roles of the sister include education of the ward nursing staff in the ongoing care of patients with tracheostomy tubes.	1) Existing tracheostomy service without outreach service.	3-year study period. *1-year pre-outreach* *2-year post-outreach*	1) ITU mortality with tracheostomy tube in situ	C = 22 (43%) I = 19 (16%) p = 0.006	Not reported.	A very poor uncontrolled study with no proper matching of cases and controls. <u>Findings:</u> Positive result on ITU mortality with tracheostomy tube in situ <u>*Potential biases/confounding factors:*</u> There are unequal time periods for pre- and post-MEWS. Patient characteristics no reported. <u>*Generalisability:*</u> A very specific patient population: patients with tracheostomy

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1026 Kenward et al. (2004) Evaluation of a MET one year after implementation.	Observational study, Retrospective before & after study **A UK hospital that uses MET.*	2-	Total no. of patients pre- & post-MET not reported. No. of patients (post-MET) = 130 <u>Inclusion for post-MET:</u> All adult admissions (age: >15 years) receiving intervention from the MET during a 12-month period, who were not in cardiac arrest at the time of call (from 1 Oct 2000 to 30 Sept 2001) <u>Exclusion for post-MET:</u> Day Care Units and Emergency Department.	<u>Post-MET:</u> Mean age = 73 (median: 76, range 20-97) Male = 57 (44%) Female = 73 (56%) **Patient characteristics of pre-MET not reported.*	1) Implementation of MET <u>Interventions by MET:</u> DNR decision; oxygen and IV fluid; oxygen and medication airway, breathing and circulatory support. **Composition of MET not reported.*	1) No MET **Further information on pre-MET not reported.*	Post-MET = 12-month **study period for pre-MET not reported.*	1) Hospital mortality 2) Cardiac arrest rate	Pre-MET = 20 *per 1000 admissions* Post-MET = 1.97 *per 1000 admissions [not significant]* Pre-MET = 2.6 *per 1000 admissions* Post-MET = 2.4 *per 1000 admissions [not significant]*	Not reported.	A very poor uncontrolled study with no proper matching of cases and controls. Information on control group (pre-MET) was not reported in the study. <u>*Findings:*</u> Negative results on both hospital mortality and cardiac arrest rate. <u>*Methodology:*</u> Study design is very poor There is no information o control, and no informatio on study period of control group. <u>*Generalisability:*</u> Poorly designed study, lack generalisability.

			***Inclusion & exclusion criteria for pre-MET not reported.* <u>Setting:</u> Single UK hospital – Selly Oak Hospital, Birmingham (a 700-bed DGH with approximately 53500 admissions per year).								

Updated Search:

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1072 Jones et al. (2005) Long term effect of a MET on cardiac arrests in a teaching	Observational study, Prospective uncontrolled before-and-after	2-	*Ns reported as No. of admissions and cardiac arrest* <u>Pre-MET (control):</u> Admissions = 16246 Cardiac arrest	**based on patients with cardiac arrest.* <u>Pre-MET (control):</u> Mean age = 73.4 Male = 41 Female = 25	1) Detailed education & information sessions for all members of hospital staff provided preceding the implementation of the MET.	1) No education 2) Traditional 'Code Blue' call system (intended for cardiac arrests &	Pre-MET = 8-month Education = 12-month Post-MET = 4yrs 2 months	<u>Primary outcomes:</u> 1) Cardiac arrest	*<u>Per 1000 admissions:</u>* Pre-MET = 4.06 Education = 2.45 OR = 0.60 (95% CI: 0.43-0.86) p = 0.004 Education = 2.45 Post-MET = 1.90 OR = 0.47 (95%	Not reported.	A poor uncontrolled study with no proper matching of cases and controls. *<u>Findings:</u>* There were significant reductions in cardiac arre between pre-MET and education phase; and between education phase and post-MET. However,

hospital.			= 66 <u>Education Phase:</u> Admissions = 25216 Cardiac arrest = 62 <u>Post-MET:</u> Admissions = 104001 Cardiac arrest = 198 <u>Inclusion/Exclusion:</u> All emergency calls for the period 01/01/1999 to 31/10/04 except calls from coronary care unit, operating room & emergency room, as well as calls in which patient had a documented 'DNR'. <u>Setting:</u> Single teaching hospital in Australia – Austin Hospital (400-bed, 21-	<u>Education Phase:</u> Mean age = 70.5 Male = 44 Female = 7 <u>Post-MET:</u> Mean age = 70.8 Male = 104 Female = 58	2) Implementation of MET <u>Composition of MET:</u> 1 ICU fellow, 1 ICU nurse, 1 medical fellow. Interventions by MET not reported. <u>*Note:*</u> *There was ongoing education to all existing staff & new staff members after the implementation of the MET.*	other sudden life-threatening medical emergencies. <u>Composition of 'Code Blue':</u> 1 anaesthetic fellow, 1 coronary care fellow & nurse, 1 ICU fellow & nurse, 1 medical fellow.		2) Survival rate following a cardiac arrest Correlation analysis between levels of MET activation (per 1000 admissions in each calendar year) & cardiac arrest rate (per 1000 admissions over the corresponding period) (Spearman-rank):	CI: 0.35-0.62) p < 0.0001 OR for survival = 0.60 (95% CI: 0.30-1.21) p = 0.15 *[not significant]* <u>Inverse correlation:</u> r^2 = 0.84, p = 0.01 The gradient of regression line = -0.061 **suggesting that for every 17 MET calls there was an associated decrease of 1 cardiac arrest.*		there was no significant reduction in survival rate. <u>*Potential biases/confounding factors:*</u> The study was not randomised, blinded or placebo-controlled. Not sure time trends were taken into account. 'Insufficient data' were included as true cardiac arrests for the education and post-MET implementation. There was ongoing education after the implementation of MET. It is possible that the observed reduction may be due to the education of staff alone. <u>*Generalisability:*</u> This is an Australian study (single hospital) with different 'TT' system compared to UK hospitals

			bed ICU, approx. 2000 admissions per year)								

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1141 Jones et al. (2006) Effect of an education programme on the utilization of a MET in a teaching hospital.	Service evaluation study. **An evaluation study of the utilization of MET.*	3	Total no. of patients = 2270 Total no. of MET calls = 2270 <u>Inclusion:</u> All medical and surgical admissions (from August 2000 to April 2004) <u>Setting:</u> Single teaching hospital in Australia – Austin Health Hospital (400 beds with 'closed' ICU model)	Not reported.	1) Implementation of MET was preceded by a preparation period (lectures & tutorial to all nursing staff; formal presentations to Divisions of Medicine & Surgery) 2) Implementation phase (notification and informed all doctors of the theory & purpose of MET and hospital policy) 3) After implementation (ongoing education & information	N/A	3.5 years	1) Overall use of the MET 2) Differences in MET usage	(Aug 2000) = 12.3 calls/1000 admissions (Apr 2004) = 40.6 calls/1000 admissions $p < 0.0001$ <u>By Apr 2004:</u> Surgical = increased 1.13 calls/1000admissions/month Medical = increased 0.23 calls/1000admissions/month $p < 0.0001$	Not reported.	This is a service evaluation study looking at the utilization of MET after introducing an education programme. The positive findings of this study suggest that a detailed nursing and medical education programme will have an effect on the utilization of the MET service. This study does not exclude other factors that might have contributed to the observed increased o MET calls (eg: word of mouth among staff members). The effect of the increase utilization of the MET service on reducing cardiac arrests or other adverse events are unknown.

					sessions were provided for new nursing & medical staff)						

Ward-Level Based Response

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
260 Paterson et al. (2006) Prediction of in-hospital mortality and length of stay using an early warning scoring system: clinical audit.	Observational, Before & after study	2-	Total no. of patients = 848 *Pre-SEWS = 413* *Post-SEWS = 435* <u>Inclusion:</u> Documentation on the observations made immediately on admission for all emergency referrals to the Combined Assessment Area (CAA) (medical & surgical assessment unit): 11days in October 2003	<u>Pre-SEWS:</u> Median age = 67 (interquartile range: 44-80) Male = 186 (45%) Female = 227 (55%) <u>Post-SEWS:</u> Median age = 69 (interquartile range: 43-79) Male = 197 (45%) Female = 228 (55%)	1) A standardised educational programme for nursing & medical staff before utilization of SEWS. Education programme included the rationale behind the SEWS and emphasised the need to alert the appropriate medical professional if the patient triggered a score of 4 or more. Staff education was delivered in lecture format and through completion of a self-directed	1) No education. Data was obtained from existing conventional observation charts.	22-day study period. *Pre-SEWS = 11-day* *Post-SEWS = 11-day*	1) Overall in-hospital mortality 2) No. of critical care admissions 3) Hospital LOS (median)	C = 24/413 (5.8%) I = 13/434 (3.0%) p = 0.046 C = 11/413 (2.6%) I = 11/435 (2.5%) **p-value not reported.* C = 2 days (interquartile range: 1-6) I = 2 days (interquartile range: 1-6) **p-value not reported.*	Not reported.	An uncontrolled before an after study that looked at the effectiveness of a aggregate scoring system on patient outcomes. <u>Findings:</u> There was significant reduction in hospital mortality after the introduction of SWES. There was reduction in th number of critical care admissions but p-value no reported. Hospital LOS were the same before and after the introduction of SEWS, again p-value not reported. <u>*Potential biases/confounding factors:*</u> No matching of cases and control; and no blinding was possible in the study

			& 11 days in November 2003. <u>Setting:</u> Single hospital in Scotland – Royal Infirmary of Edinburgh.		learning pack. 2) Utilization of the SEWS <u>Composition:</u> This is a ward level based study on the introduction of SWES, a scoring system, there was no CCOT. <u>Interventions:</u> **No specific education on patient care management, but ward staff were encouraged to refer to the guidelines on the reverse of the chart.* <u>Note:</u> Threshold for MEWS = ≥ 5 Threshold for SWES = 4 *SWES includes oxygen saturation as a physiological parameter.						Very short study period (2 days). <u>The author suggested tha</u> The explanation for the significant reduction in hospital mortality is unclear. The intensive sta education programme might have been an important contributory factor. <u>*Generalisability:*</u> SWES is similar to MEWS (only with lower threshold and oxygen saturation wa added as physiological parameter) which is widel used in the UK.

5.4.4 References – Topic 2

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Norwood MG, Spiers P, Bailiss J et al. (2004) Evaluation of the role of a specialist tracheostomy service. From critical care to outreach and beyond. *Postgraduate Medical Journal* 80 (946) : 478-480.

Paterson R, MacLeod DC, Thetford D et al. (2006) Prediction of in-hospital mortality and length of stay using an early warning scoring system: clinical audit. *Clinical Medicine* 6 (3) : 281-284.

Pittard AJ (2003) Out of our reach? Assessing the impact of introducing a critical care outreach service. *Anaesthesia* 58 (9) : 882-885.

Priestley G, Watson W, Rashidian A et al. (2004) Introducing Critical Care Outreach: a ward-randomised trial of phased introduction in a general hospital. *Intensive Care Medicine* 30 (7) : 1398-1404.

Salamonson Y, Kariyawasam A, van Heere B et al. (2001) The evolutionary process of Medical Emergency Team (MET) implementation: reduction in unanticipated ICU transfers. *Resuscitation* 49 (2) : 135-141.

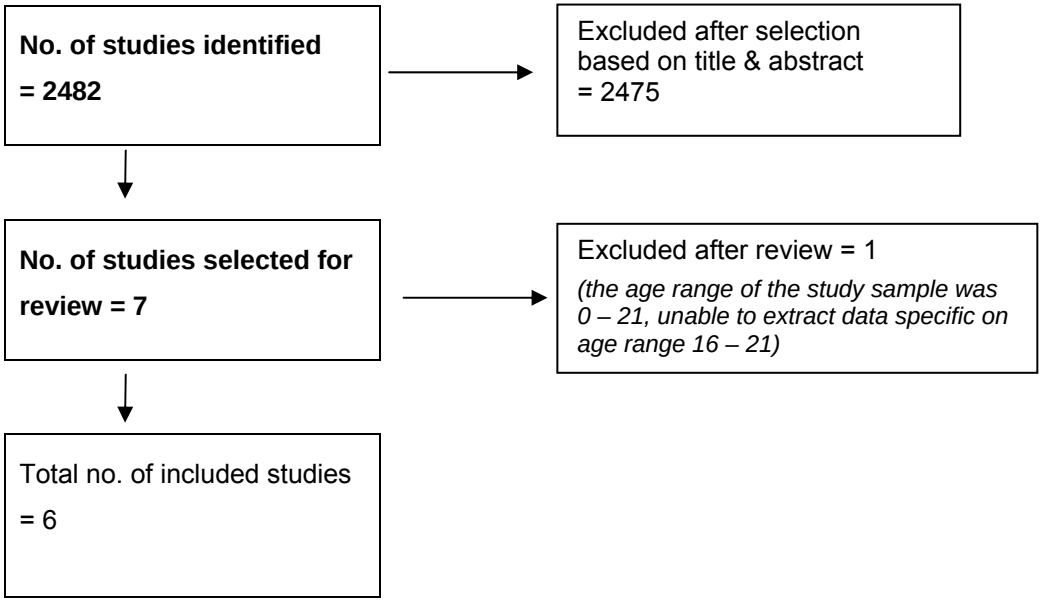
Story DA, Shelton AC, Poustie SJ et al. (2004) The effect of critical care outreach on postoperative serious adverse events. *Anaesthesia* 59 (8) : 762-766.

Subbe CP, Davies RG, Williams E et al. (2003) Effect of introducing the Modified Early Warning score on clinical outcomes, cardio-pulmonary arrests and intensive care utilisation in acute medical admissions. *Anaesthesia* 58 (8) : 797-802.

5.4.5 Topic 3: Discharge of patient from Critical Care Areas (CCAs) - Timing of Transfer

*** Does not include decision to discharge a patient from CCA. It starts at the point at which the decision has been made that the patient can be discharged***

Volume of Evidence



Type of study

Total no. of studies = 6	Observational study = 6 (Cohort Study)

Topic 3: Discharge of patients from Critical Care Areas (CCAs) - Timing of Transfer

*** Does not include decision to discharge a patient from CCA. It starts at the point at which the decision has been made that the patient can be discharged***

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2562 Level of evidence: (2+) Retrospective cohort study Goldfrad and Rowan (2000) Consequences of discharges from intensive care at night. **Case-mix adjustment was carried out using the APACHE II method.*	*<u>UK national databases:</u>* 1) UK APACHE II study database (1988-1990) = 10806 admissions to 26 ICUs 2) CMPD (1995-1998) = 21295 admissions to 62 ICUs. After case-mix adjustment: Day discharges = 15747 Night discharges = 1009 *Note: Only data 2) was used to investigate the consequences of discharge at night.*	*<u>CMPD (1995-1998) after case-mix adjustment:</u>* <u>Day discharges:</u> Mean age = 58.2 (95% CI: 57.9-58.5) Mean APACHE II score = 14.6 (95% CI: 14.5-14.7) <u>Night discharges:</u> Mean age = 57.5 (95% CI: 56.4-58.7) Mean APACHE II score = 15.5 (95% CI: 15.1-16.0)	CMPD: Investigation of the consequences of discharge at night = 4 years	*<u>'Night' was defined as:</u>* *- From 2200 to 0659* *- From 0000 to 0459* 1) Ultimate ICU mortality 2) Ultimate hospital mortality 3) Odds of hospital death (night discharges "2200-0659") compared with day discharges 3a) Crude (unadjusted) 3b) Case-mix adjusted 3c) After adjustment for premature discharge	 Night was 2.5-fold greater than Day (X^2 = 21.96, p = 0.00) Night was 1.4-fold greater than Day (X^2 = 23.05, p = 0.00) OR = 1.46 (95% CI: 1.18-1.80) Adj OR = 1.33 (95% CI: 1.06-1.65) Adj OR = 1.17 (95% CI: 0.92-1.49)	Not reported.	A well designed cohort study with case-mix adjustment. <u>Chief findings:</u> Night discharges had a higher crude (unadjusted) and case-mix adjusted hospital mortality compared to Day discharges. When looking at the data on 'direct discharge to the wards', Night discharges also had a higher crude and case-mix adjusted hospital mortality compared to Day discharges. For both groups the findings were statistically non-significant once additional adjustment was made for "premature discharge". <u>The author suggested that:</u> - The main reason why Night discharges did worse than Day discharges in this study is that

	Exclusion criteria: - Patients age < 16 years. - Deaths in ICUs. **CMPD: Intensive Care National Audit & Research Centre's Case Mix Programme Database.*			4) Odds of hospital death (night discharges "0000-0459") compared with day discharges 4a) Crude (unadjusted) 4b) Case-mix adjusted 4c) After adjustment for premature discharge ***After adjusting for a possible cluster effect of ICUs, night discharges remained significant with p = 0.036* 5) Odds of hospital death *for discharges direct to the ward* night discharges ("2200-0659") compared with day discharges 5a) Crude (unadjusted) 5b) Case-mix adjusted 5c) After adjustment for premature discharge 6) Odds of hospital death *for discharges direct to the ward* night discharges ("0000-0459") compared with day discharges 6a) Crude (unadjusted) 6b) Case-mix adjusted 6c) After adjustment for	 OR = 1.62 (95% CI: 1.19-2.21) Adj OR = 1.53 (95% CI: 1.11-2.13) Adj OR = 1.33 (95% CI: 0.95-1.87) OR = 1.42 (95% CI: 1.11-1.82) Adj OR = 1.37 (95% CI: 1.06-1.78) Adj OR = 1.18 (95% CI: 0.90-1.56) OR = 1.73 (95% CI: 1.21-2.48) Adj OR = 1.73 (95% CI: 1.19-2.53) Adj OR = 1.47		they are more likely to be premature in the view if the clinicians involved. - Other factors that might account for a worse outcome for Night discharges in this study included poorer quantity and quality of care available at night both during transfer and at the destination. - Transfers in the middle of the night may be traumatic both physically and psychologically for patients. Methodological limitations: The use of UK APACHE II method for case-mix adjustment – can never be certain that all potential risk factors have been taken into account, although the model was developed and extensively validated in the UK. There could be still unknown confounders such as will-to-live or genetic predisposition, and this uncertainty can only be resolved by a randomised trial. Retrospective collection of data relies on the accuracy of medical records. The definition of "premature discharge" is open to bias. However, The study was based on UK national databases which means the results apply to UK hospitals.

				premature discharge "Premature discharge" was based on an analysis of the data collected under the heading of "reason for discharge from ICU" and was based on a clinician's subjective assessment of a patient's readiness for discharge in the light of the needs of other patients for the ICU beds. No attempt was made to impose standard explicit criteria for this variable. ***Premature discharge and Night discharge were significantly correlated.*	(95% CI: 0.97-2.17) r = 0.53, p < 0.01		

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2540 Level of evidence: (2+) Retrospective Cohort Study Beck et al. (2002) Waiting for the break of dawn? The effects of discharge	Patients admitted consecutively to ICU from 01/01/1996 to 31/03/2000. *Total no. of ICU patients after exclusion = 1654* Exclusion: - Admissions with a diagnosis of primary burn injury. - ICU stay of less	All 1654 admissions: Mean age = 57 (SD: 19) Female = 634 (38.3%) Male = 1020 (61.7%) Mean APACHE II = 18.3 (SD: 18.7)	4 years & 4 months.	Definitions: Early discharge: 0800-1959 Late discharge: 2000-0759 Crude (unadjusted) post-ICU mortality rates Adjusted overall mortality risk	 Early discharge = 11.2% Late discharge = 18.8% X^2 = 13.1, p = 0.0003 Late discharges compared with Early discharges: Adj RR = 1.70 (95% CI: 1.28-2.25)	Departmental funds.	A reasonably well designed cohort study. Chief findings: The results suggested that Late discharges from ICU would increase the mortality risk of patients. Potential Confounding factors: For discharged to HDU, the CI was relatively wide. This suggests that the sample size of this group may have simply been too small to estimate precisely the magnitude of this association.

time, discharge TISS scores and discharge facility on hospital mortality after intensive care. **Adjusted for disease severity (APACHE II).*	than 4-hour. - Aged under 16 years old. - Patients who died in ICU. - Data on subsequent ICU readmissions - Patients directly discharged home. <u>Setting:</u> UK single district hospital – Portsmouth Hospitals NHS Trust			Adjusted mortality risk for patients discharged directly to wards Adjusted mortality risk for patients discharged directly to HDU	Late discharges compared with Early discharges: Adj RR = 1.87 (95% CI: 1.36-2.56) Late discharges compared with Early discharges: Adj RR = 1.35 (95% CI: 0.77-2.36)		Retrospective collection of data relies on the accuracy of medical records. This is a UK study which is generalisable.

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2503 Level of evidence: (2+) Retrospective Cohort Study	<u>Data extracted from the Canadian national database:</u> Critical Care Research Network's Minimum Dataset (MDS) between September 2003	Day-time discharge: Mean age = 61.7 (SD: 17.5) Male = 57.4% Female = 42.6% APACHE II = 15.0 (SD: 7.4) Night-time	12-month	<u>Definitions:</u> Day-time: 0700-2059 Night-time: 2100-0659 0000-0659 <u>Primary outcome:</u> Crude (unadjusted) In-hospital mortality rate	Day = 9.0% Night = 11.8% P < 0.001	Not reported.	A reasonably well designed cohort study. <u>Chief findings:</u> The results indicated that patients discharged from ICU at night have an increased risk of dying in hospital compared with those discharged during the day.

Priestap and Martin (2006) Impact of intensive care unit discharge time on patient outcome. **Adjusted for severity of illness (APACHE II)*	and August 2004. Total no. of Day-time discharges = 42290 Total no. of Night-time discharges = 4772 <u>Inclusion Criteria:</u> All patients admitted to the ICUs who were discharged to the ward were eligible for inclusion in this study. <u>Exclusion criteria:</u> - Patients ≤ 16 years of age - Admitting following cardiac surgery - Admitted following the initial admission for patients readmitted to the ICU within the same hospital stay - Admitted due to a lack of available ward or specialty care beds - Transferred to another acute care facility <u>Setting/Participating Hospitals:</u>	discharge: Mean age = 61.6 (SD: 17.7) Male = 58% Female = 42% APACHE II = 15.7 (SD: 7.7)		Adjusted OR in-hospital mortality – 2100-0659 (multiple logistic regression) Adjusted OR in-hospital mortality – 0000-0659 (multiple logistic regression) <u>Secondary outcomes:</u> Crude (unadjusted) Median ICU LOS Crude (unadjusted) Median hospital LOS Adjusted ICU LOS Crude (unadjusted) Unplanned readmission within 48hrs of ICU discharge	Adj $OR_{2100-0659}$ = 1.22 (95% CI: 1.10-1.36) Adj $OR_{0000-0659}$ = 1.26 (95% CI: 1.07-1.49) Day = 2.14 days (IQR: 1.09-4.36) Night = 2.30 days (IQR: 1.23-4.60) P = 0.008 Day = 11 days (IQR: 7.0-22) Night = 12 days (IQR: 7.0-23) P = 0.011 Night discharges had a significantly shorter ICU LOS than Day discharges: p < 0.001 Day = 1.7% Night = 2.4% P< 0.001		<u>Methodology Limitations:</u> - The Hosmer-Lemeshow goodness-of-fit test was significant, suggesting poor correspondence between the expected probability of mortality produced by the model and the actual mortality in the study population. - The study did not adjust for advanced directives (Ads) and DNR. - The admissions excluded from the regression analyses due to missing data were significantly different from those included ie. on mean age, sources, admission diagnosis, operative status, time of discharge. Although these data only accounted for 2% of all admissions. Severity of illness at the time of ICU discharge may be a more important adjustment on post-ICU mortality than severity of illness on admission. Retrospective collection of data relies on the accuracy of medical records. This is a Canadian study that may have limited generalisability to UK settings.

	31 Canadian hospitals Community hospital = 23 Teaching hospital = 8						

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2517 Level of evidence: (2+) Prospective Cohort Study Duke et al. (2004) Night-shift discharge from intensive care unit increases the mortality-risk of ICU survivors. **Adjustment for severity of illness, LMT status, premature or delayed ICU discharge.*	Total no. of ICU admission between 01/01/1999 and 30/04/2003 = 2247 Total no. of included ICU admission = 1870 *Day = 878* *Evening = 700* *Night = 292* <u>Inclusion:</u> Only the first admission to ICU was included, not readmissions. <u>Exclusion:</u> - Death in ICU - mAge < 16 - Were transferred to another hospital - Had an ICU LOS < 8 hours <u>Setting:</u> Single Australian teaching hospital – Northern Hospital, Melbourne.	<u>Of total of 2247 admissions:</u> Median age = 62 (IQR: 42-73) Median APACHE II score = 15 (IQR: 10-21) Median APACHE II $_{pm}$ = 0.13 (IQR: 0.05-0.30)	52-month	<u>Definitions:</u> Day = 0730-1500 Evening = 1500-2200 Night = 2200-0730 Crude (unadjusted) Case-fatality rate Crude (unadjusted) Unplanned ICU readmission Logistic regression analysis – after adjustment for severity of illness (significant predictors of hospital death at the time of ICU discharge) Variables included: times of discharge, delayed discharge, premature discharge, LMT.	Night (8.2%) compared to Day (4.6%) & Eve (4.0%), p = 0.016 Day (3.5%) compared to Eve (5.1%) & Night (7.5%), p =0.015 APACHE II $_{pm}$ Adj RR = 3.3 (95% CI: 1.3-7.6), p < 0.001 LMT order Adj RR = 5.1 (95% CI: 2.2-12), p < 0.001 Night discharge Adj RR = 1.7 (95% CI: 1.03-2.9), p = 0.03	Not reported.	A reasonably well designed cohort study. <u>Chief findings:</u> The study suggested that the timing of ICU discharge, in addition to the (initial) severity of illness and LMT order, influenced the outcome of ICU survivors. The case-fatality rate in ICU survivors was higher for those discharged during the night-shift discharge, even after the adjustment of possible confounding factors. <u>The author suggested that:</u> The possible reasons for the finding in this study were – - Staff availability and nurse: patient ratios in the general wards were lower during night shift. - Medical staff: patient ratios in the general wards fell by at least 80% overnight in this particular hospital. - There may be insufficient time for adequate handover and for regular patient assessment and observations. Communication errors during handover may lead to adverse patient events. <u>Potential biases:</u> - The study population was an uncontrolled and heterogeneous group from one institution. - Though not statistically significant, patients discharged during evening and night shifts have greater

							severity of illness (APACHE II $_{pm}$) and older in age. - Severity of illness at the time of ICU discharge may be a more important adjustment on post-ICU mortality than severity of illness on admission. - The CI for the RR of timing for discharge was close to unity and therefore a Type I error due to an institutional or methodological bias is possible. This is an Australian single hospital study that may have limited generalisability to UK settings.

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2507 Level of evidence: (2+) Retrospective Cohort Study Tobin and Santamaria (2006) After-hours discharges from intensive	10903 patients discharged alive from ICU to hospital wards between 01/01/1992 and 31/12/2002. <u>Setting:</u> Australia - Single hospital – a 400-bed tertiary referral hospital associated with a university.	*<u>All 12079 patients admitted to ICU (1992-2002):</u>* Male = 65% Female = 35% Median age = 64 (range: 13-98) Median APACHE II = 13 (range: 0-53) <u>Health Units:</u> General medicine =	The cohort was analysed for 2 periods: 1992-1994 & 2000-2002.	<u>Definitions:</u> Morning shift (07:00-14:59) Afternoon shift (15:00-21:59) Night shift (22:00-06:59) *<u>Primary outcome:</u>* <u>Hospital mortality after discharge from ICU (discharge alive):</u> Morning shift (reference): Afternoon shift (unadjusted)	(1992-1994) = 7.18% (2000-2002) = 21.92% OR = 3.63 (95% CI: 3.05-4.30)	Not reported.	Retrospective cohort design with limited descriptions of inclusion/exclusion criteria. <u>Chief findings:</u> Afternoon and night discharges were associated with higher post-ICU mortality. <u>The author commented that:</u> - Several factors might explain these results. Transfer from the ICU to a ward is associated with a significant reduction in clinical observation and monitoring, with

care are associated with increased mortality **Adjusted for severity of illness (APACHE II) and origin of admission.*		15% Special medicine = 10% General surgery = 10% Special surgery = 65%		Night shift (unadjusted) <u>Multivariate analysis (predictor of mortality after ICU discharge):</u> Morning shift (reference): Afternoon shift Night shift	(1992-1994) = 1.36% (2000-2002) = 5.86% OR = 4.52 (95% CI: 3.15-6.64) Adj OR = 1.36 (95% CI: 1.08-1.70) Adj OR = 1.63 (95% CI: 1.03-2.57)		the ratio of nurses to patients varying from 1:4 to 1:10. - This study did not have information to suggest premature discharge at night shift. - A proportion of patients discharged at night may be those for whom continued ICU care is judge futile or for whom palliative care has been instituted (palliative discharges may have skewed the mortality rates when defined by nursing shifts). <u>Potential biases/confounding factors:</u> In analysis of after-hours discharges, no attempt was made to differentiate between premature discharge and delayed discharge. Similarly, whether the patient was discharged for active management or for palliative care was not coded in the ICU database and was not included in the analysis. Retrospective collection of data relies on the accuracy of medical records. Single hospital study in Australia – case-mix, patient-to-staff ratios may vary in other hospitals. No inclusion/exclusion criteria for study population.

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2525 Level of evidence: (2+) Retrospective Cohort Study Uusaro et al. (2003) The effects of ICU admission and discharge times on mortality in Finland. **Adjusted for SAPS II, TISS and whether restrictions were set for future care (eg: DNR).*	Consecutive series of 23134 emergency admissions from Jan 1998 to June 2001. *No. of patients for crude analysis = 20636* *No. of patients for logistic regression analysis (after adjustment) = 14308* <u>Setting:</u> 18 ICUs in Finland: 16 in central hospital, 2 in university hospitals.	Mean SAPS II for the entire population was = 34±17 (mean±SD)	30-month	<u>Definitions:</u> Weekend = from 1600 Friday to 2400 Sunday 'Out of office hours' = 1600-0800 'Office hours' = 0800-1600 Crude (unadjusted) hospital mortality rate Logistic regression analysis – hospital mortality (after adjustment) Crude (unadjusted) hospital mortality rate Logistic regression analysis – hospital mortality (after adjustment)	Office-hour discharge = 9.8% Out of office-hour discharge = 11.5% p = 0.002 Adj OR with Out of office-hour discharge = 1.11 (95% CI: 0.93-1.31), p = 0.24 *[not significant]* Weekday discharge = 10.2% Weekend discharge = 9.2% p = 0.09 *[not significant]* Adj OR with Weekend discharge = 0.88 (95% CI: 0.73-1.07) *[not significant, p-value not reported]*	Not reported.	Retrospective cohort design with limited descriptions of inclusion/exclusion criteria. <u>Chief findings:</u> No association between the time of discharge from the ICU and further hospital mortality after taken into account of SAPS II, TISS and whether restrictions were set for future care. <u>Potential biases/confounding factors:</u> The 'Out of office-hour' was considerable wide (16 hours) compared to other studies that used more specific 'night-time'. The study has high ICU mortality (10.9%) and high hospital mortality (20.7%) in the first place. Retrospective collection of data relies on the accuracy of medical records. This is a study from Finland, thus there is the issue of generalisability to UK settings.

5.4.6 Topic 3 References

Beck DH, McQuillan P, Smith GB (2002) Waiting for the break of dawn? The effects of discharge time, discharge TISS scores and discharge facility on hospital mortality after intensive care. *Intensive Care Medicine* 28 (9) : 1287-1293.

Duke GJ, Green JV, Briedis JH (2004) Night-shift discharge from intensive care unit increases the mortality-risk of ICU survivors. *Anaesthesia & Intensive Care* 32 (5) : 697-701.

Goldfrad C, Rowan K (2000) Consequences of discharges from intensive care at night. *Lancet* 355 (9210) : 1138-1142.

Priestap FA, Martin CM (2006) Impact of intensive care unit discharge time on patient outcome. *Critical Care Medicine* 34 (12) : 2946-2951.

Tobin AE, Santamaria JD (2006) After-hours discharges from intensive care are associated with increased mortality. See comment. *Medical Journal of Australia* 184 (7) : 334-337.

Uusaro A, Kari A, Ruokonen E (2003) The effects of ICU admission and discharge times on mortality in Finland. *Intensive Care Medicine* 29 (12) : 2144-2148.

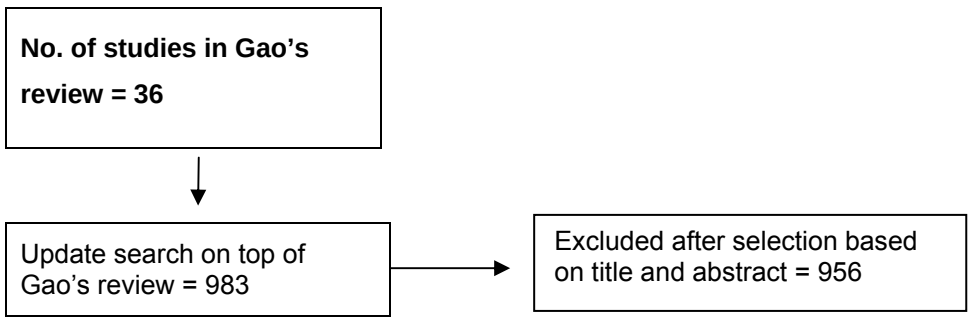
5.5 Inclusion and Exclusion Criteria

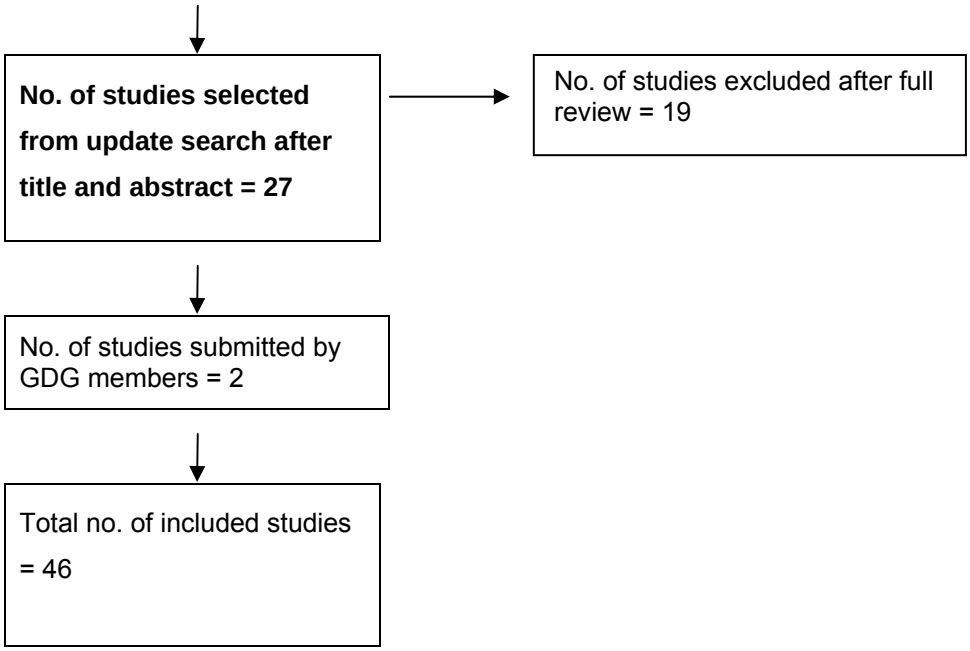
Clinical Evidence: Inclusion and Exclusion Criteria

Chapter 1: Identification and evaluation of risk scoring tools

Language	English
Status	Published papers (full papers only), papers in-press (full papers only).
Study Design	All study types.
Population	All adult patients in hospital, including patients in the emergency department but excluding patients in critical care areas.
Content of papers *(inclusion/exclusion criteria)*	1. Studies describing the development of a tool which triggers a mandated response to predetermined patterns of physiological derangements and includes 'periodic observation' of three or more of the following: • Respirations • Blood pressure • Heart rate • Urine output • O2 saturation • Body temperature • Level of consciousness 2. Studies testing any aspect of reliability or validity of tools which meet the above criteria e.g. sensitivity, specificity, predictive validity. 3. Studies testing the utility of tools which meet the above criteria e.g. acceptability to staff and patients, completion time. 4. Papers describing the use of a tool which meets the above criteria.
Note:	Search strategy for Chapter 1 was based on Gao et al's systematic review. The technical team had re-run an update search based on Gao et al's review and specifically looked at studies in emergency department that were excluded by Gao et al's original study.

Flow-chart 1: volume of evidence for Chapter 1

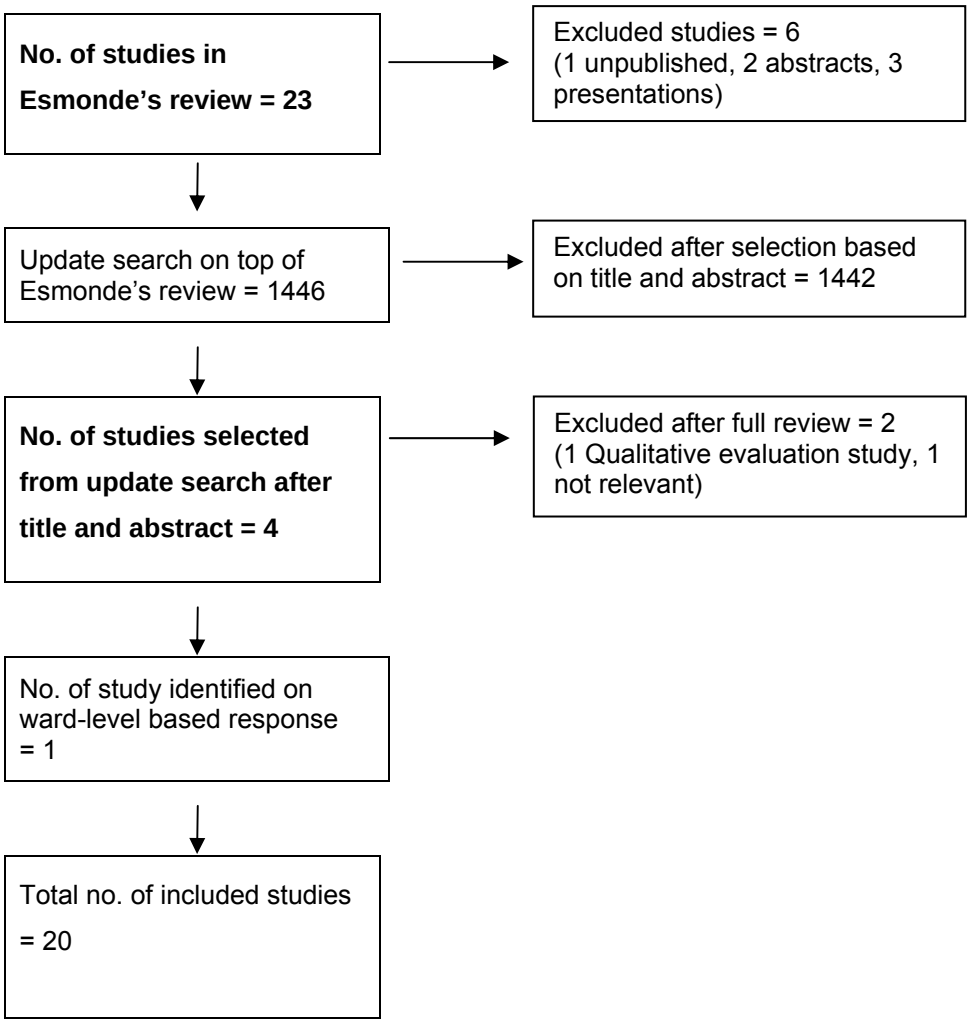



No. of studies selected from update search after title and abstract = 27
No. of studies excluded after full review = 19
No. of studies submitted by GDG members = 2
Total no. of included studies = 46

Chapter 2: Response strategies for patients identified as having a deteriorating clinical condition

Language	English
Status	Published papers (full papers only), papers in-press (full papers only).
Study Design	All study types.
Population	All adult patients in hospital, excluding patients in emergency department and critical care areas.
Content of papers *(inclusion/exclusion criteria)*	1. Studies describing or exploring the impact of critical care outreach services on patient and service outcomes; and studies introducing critical care outreach services in hospital. Critical care outreach services encompassed a wide range of activities such as Critical Care Outreach Team, Patient-At-Risk Team, Medical Emergency Team, Rapid Response Team, ward-level response or any other similar configurations. The outcomes were any measures of patient health outcomes such as: • Mortality rate • Frequency of cardiac arrests • Hospital/ICU length of stay • Unplanned ICU admission • ICU re-admission 2. Studies exploring the impact of ward-level based response on patient and service outcomes. 3. Studies describing or evaluating the utility or implementation of critical care outreach services/activities which meet the above criteria e.g. effect of an education programme on the utilization of critical care outreach services/activities.

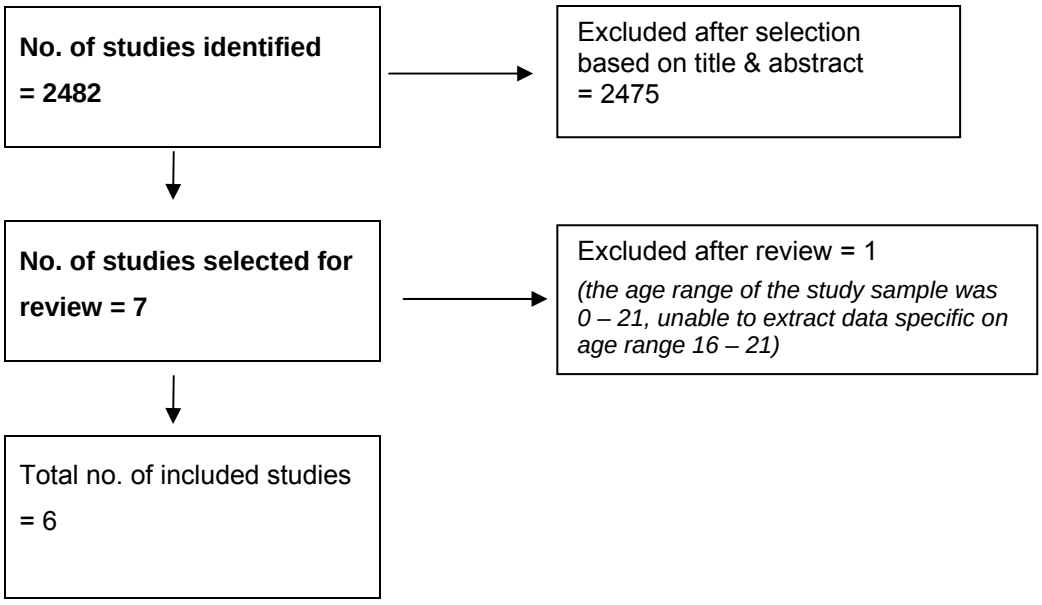
Flow-chart 2: volume of evidence for Chapter 2



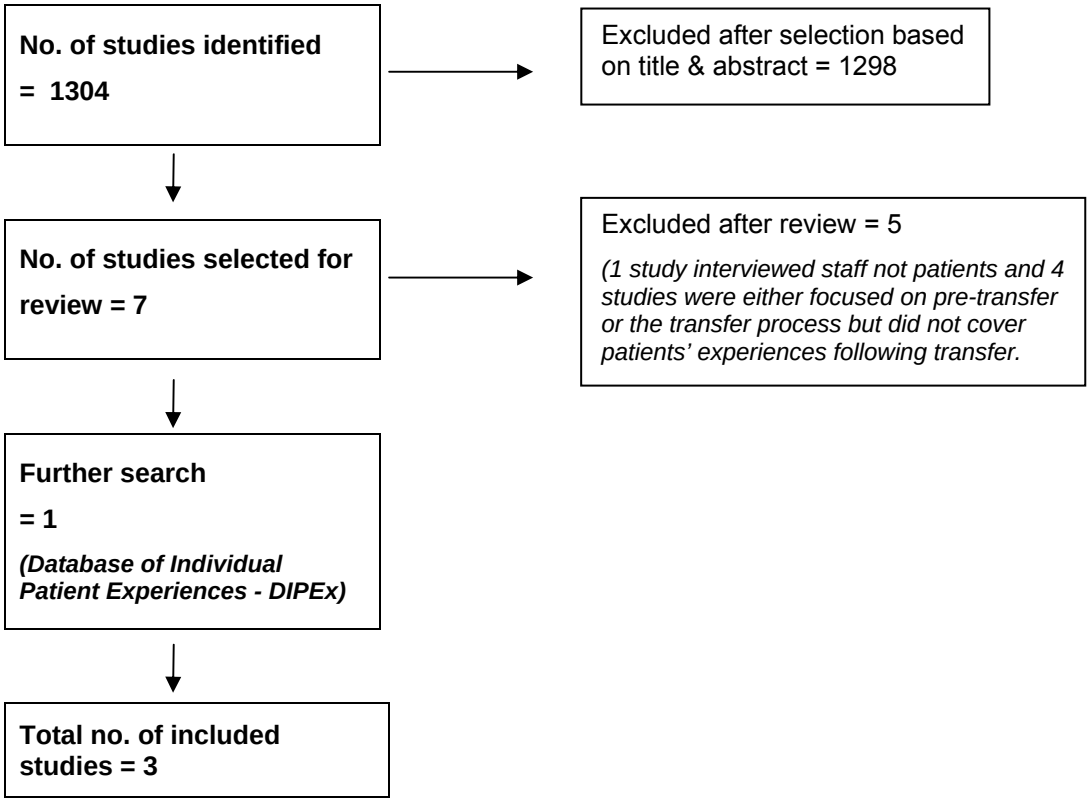
Chapter 3: Discharge of patients from critical care areas

Sub-question 1.	Timing of transfer
Language	English
Status	Published papers (full papers only), papers in-press (full papers only).
Study Design	All study types.
Population	Adult in-patients in critical care areas.
Content of papers *(inclusion/exclusion criteria)*	1. Studies exploring the impact of 'out of office hours' transfer compared to 'office hours' transfer on patient outcomes such as: • Mortality rate • Re-admission to critical care areas • Adverse events 2. Selection did not include the study on decision to discharge a patient from critical care areas. It started at the point at which the decision had already been made.
Sub-question 2.	What interventions can be delivered to patients on general wards following discharge from Critical Care Areas to improve health outcomes?
	Please refer to Chapter 2. • Studies exploring interventions delivered in the immediate post discharge phase. Does not cover rehabilitation.
Sub-question 3.	What elements of care on the general ward are viewed as important by patients in the immediate period following discharge from critical care areas?
Language	English
Status	Published papers (full papers only), papers in-press (full papers only).
Study Design	All study types.
Population	Adult in-patients on general wards following discharge from critical care areas.
Content of papers *(inclusion/exclusion criteria)*	1. Studies describing patient's experiences and views on care provided on general ward following discharge from critical care areas. 2. Selection did not include factors causing relocation stress and provision of rehabilitation. 3. Selection did not include experiences and views of patient's family or carers. 4. Selection did not include healthcare professional's views on patient's experiences and what they need.

Flow-chart 3a: volume of evidence for Chapter 3 (sub-question 1.)



Flow-chart 3c: volume of evidence for Chapter 3 (sub-question 3.)



Health Economics Evidence: Inclusion and Exclusion Criteria

Partial and full economic evaluations (evaluations that consider both costs and consequences) published in English linked with the clinical questions covered in this guideline. No directly relevant published studies were identified, save for a book chapter that cited limited information on the direct costs of outreach services. Unpublished, ongoing research (see chapter 3.3.10 for details) however was identified, and used to inform the appropriate sections of the guideline.