CRITICAL CARE OUTREACH AND THE USE OF EARLY WARNING SCORING SYSTEMS; A LITERATURE REVIEW

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Abstract: The aim of this paper is to look at patient surveillance of "*at risk*" patients and how this is provided by critical care outreach services in the UK. Patient surveillance is a relatively recent development in the assessment of the seriously ill patient, within the framework of the document C*ritical Care Without Walls*. Early recognition of potential and actual deterioration in the patient's condition is essential, and should be accompanied by an appropriate response for early intervention. Timely access to high dependency and critical care facilities is crucial in effectively managing sick ward patients. Since the publication of *Comprehensive Critical Care* (2000), Early Warning Scoring systems (EWS) have been introduced onto the wards to improve the identification of patients deteriorating into critical illness. EWS tools are based upon the allocation of "*points"* to physiological observations, the calculation of a total '*score'* and the designation of an agreed calling "*trigger"* level. Many Trusts report evidence of the benefit of track and trigger warning systems, in improving single process steps in care of the critically ill. Physiological tracking and triggering systems can lead to measurable direct and indirect improvements in the quality of patient care. Whilst supporting the development of outreach services and EWS tools, it is imperative that the future of any outreach service must be responsive to post-implementation audit and research.

Key words: critical care, outreach, Early Warning Scoring systems, nurse, algorithm

BACKGROUND

The National Health Service in the UK has been responding to and re-addressing the ever-changing needs of patients. At times, substantial changes in healthcare policy are implemented in order to deliver efficient and effective health care. Service modernization aims to improve performance management and capacity planning (Department of Health, 2000). This implies that it should take into consideration the healthcare pressures that have arisen when planning for the future.

A lack of Intensive Care Unit beds had sometimes resulted in patients being transferred long distances, or elective operations that required an intensive care bed being cancelled. This had led to bad publicity for the government in the winter months of 1998–1999, and 1999–2000. In 1999, the Department of Health (2000) published the document of *Comprehensive Critical Care*, as evidence of the government's wish to reform and modernise health services. As well as recommending additional critical care beds it sets out a new approach to critical care that is based on patients' needs rather than their location in the hospital.

Comprehensive Critical Care (2000) recommends that critical care services should be provided, not only for those patients who are critically ill, but also for patients at risk of critical illness. The UK government had acted upon the 1999 Audit Commission report on critical care services *Critical to Success*, which recommended setting up outreach teams, ICU follow-up and increasing the involvement of Trust boards. This report had been critical of the delivery and organization of critical care services.

Since then, Critical Care Outreach service has evolved significantly. It was introduced in order to speed up the identification of sick patients on the ward and so facilitate timely medical intervention, which may avert critical care admissions. The Intensive Care Society (2002), define critical care outreach as "*a multidisciplinary approach to the identification of patients, at-risk of developing critical illness, and those patients recovering from a period of critical illness, to enable early intervention or transfer (if appropriate) to an area suitable to care for that patient's individual needs*".

The Development of Critical Care Outreach

Timely access to high dependency and critical care facilities is crucial in effectively managing sick ward patients, and in ensuring that valuable critical care and ward-based resources are not misused. However, there was a continuing capacity problem in the provision of critical care facilities in acute care trusts (Coombs and Dillon, 2002). Consequently, there had been growing concerns about the management of critically ill patients outside the intensive care setting (McGloin *et al*, 1997; McQuillan *et al*, 1998; Goldhill, 2000).

Evidence began to emerge that suggested some of the patients admitted to ICU from the wards had received sub-optimal care and that in some cases their admissions were preventable (Mc Quillan *et al,* 1998; Mc Gloin *et al*, 1999). However, Lee *et al* (1995) found that an abnormal respiratory rate and tachycardia would not necessarily act as a catalyst for intervention, and sufficient care on the wards was associated with increased morbidity and mortality among patients (McQuillan *et al*, 1998).

Subsequently, strategies for reducing the occurrence of sub-optimal care had been proposed, which focused on the identification of patients at risk of critical illness and the provision of some form of critical care outreach service to provide expert advice in the management of these patients (Lee *et al*, 1995; Goldhill, 1997; Morgan *et al*, 1997; Audit Commission, 1999). Sub-optimal care was described as a lack of knowledge regarding the significance of findings relating to airway dysfunction, breathing and circulation, which resulted in these aspects of care being missed, misinterpreted or mismanaged.

Other studies suggested that sick patients who had a cardiac arrest or were admitted to ICU often displayed signs of deterioration in their clinical observations in the hours prior to the event, (Franklin and Mathew, 1994; Wood and Smith, 1999; Goldhill *et al*, 1999). The message appeared to be that more could be done on the wards to prevent patients deteriorating into suffering a cardiac arrest or needing ICU/HDU admission.

Comprehensive Critical Care recommended that critical care services should be provided, not only for those patients who are critically ill, but also for patients at risk of critical illness and those recovering from it. Since then, published studies evaluating the effects of an Early Warning Score (EWS) or Patient at Risk score (Goldhill *et al*, 1999; Stenhouse *et al*, 2000) provide some rationale for the introduction of critical care outreach.

Goldhill *et al* (1999) evaluated a Patient at Risk Team consisting of an ICU consultant, a senior ICU nurse, and the duty medical or surgical registrar. The wards were given criteria based on physiological abnormalities such as an oxygen saturation of less than 90%. If a patient met the criteria then ward nurses were prompted to inform the doctor caring for them. Doctors could request help from the patient at risk team, and in exceptional circumstances nurses themselves could contact them. The team assessed 63 patients during the study period. Although the results showed that the criteria of physiological abnormalities were not able to reliably predict which patients would get admitted to ICU, the study revealed that a significantly lower incidence of cardiac arrest before admission to ICU in the patients seen by the team 3.6%, as compared with those not seen 30.4% ($P<0.005$).

Another approach to the problem of sub optimal care was the concept of the Medical Emergency Team (MET). This was introduced at the Liverpool hospital in Australia by Lee *et al* (1995). The MET consisted of nursing and medical staff trained in resuscitation. Ward staff were able to call the MET for patients with abnormal physiological variables, or specific conditions such as shock, excessive bleeding or upper airway obstruction. The aim of the team was early recognition and prompt treatment of those patients at risk of cardiac arrest.

Parr *et al* (2001) analysed the MET calls and resulting patient outcomes over 1 year. The results showed that 45% of the patients seen by MET were admitted to ICU. The authors concluded that the MET provided objective criteria to identify which patients became critically ill. In a very recent study of MET, Buist *et al* (2002) demonstrated that the introduction of the MET reduced the number of unexpected cardiac arrests by 50%, and reduced the mortality rate from 77 to 55%. Medical Emergency Teams do not appear to be very common in England, and one argument against them is that they their interventionist approach can deskill nurses on the wards (Mercer *et al*, 1999).

Critical care outreach is delivered variably across the UK (DoHMA, 2003). A large proportion of hospitals provide critical care education for ward based staff, and also use audit to determine important issues (National Outreach Survey, 2002). Education and training has been offered to general ward staff. Different forms of outreach service have evolved depending on local priorities and resources. Early Warning Scoring systems have been introduced onto the wards to improve the identification of patients deteriorating into critical illness.

Early Warning Scoring Systems

Scoring systems were developed in response to studies that showed patients who suffered an in hospital cardiac arrest often had abnormal physiological values charted in the preceding hours (Wood & Smith, 1999). In addition, patients admitted from the ward to ICU, often had abnormal physiological values present in the previous 24 hours (Schein *et al*, 1990; Franklin and Mathew, 1994; Goldhill, 1997; McQuillan *et al*, 1998; McGloin *et al*, 1999; Goldhill *et al*, 1999). In Goldhill's study, the most common abnormalities found in patients admitted to ICU from the ward were tachypnoea and an altered level of consciousness. There waa also derangement of heart rate, arterial blood pressure, arterial oxygen saturation and urinary output (Goldhill *et al,* 1999).

However, studies had indicated that nurses often failed to inform the doctor of the patient's clinical deterioration (Schein *et al*, 1990; Franklin and Mathew, 1994). This was defined as sub optimal care. McQuillan *et al* (1998) identified the main causative factors of sub optimal care as failure of organization, lack of knowledge, failure to appreciate clinical urgency, lack of supervision, and failure to seek advice. Goldhill *et al* (1999) used the following criteria to call the "*patient at risk*" team (PART). The senior nurse would call the doctor and/or the PART team for three or more of the following criteria:

- Respiratory rate of ≥25 or <10 breaths per minute.
- Arterial systolic blood pressure of <90mmHg.
- Heart rate of ≥110 or <55 beats per minute.
- Not fully alert and orientated.
- Oxygen saturation of <90 per cent.
- Urine output over the last four hours of <100ml.
- Respiratory rate ≥35 breaths per minute or a heart rate ≥140 beats per minute.

The implementation of a structured scoring system and simple algorithm defining the situation appropriate for seeking medical intervention was thought as an appropriate way to help nurses in identifying patients at risk more effectively. Following this, in the mid 1990s "*calling criteria*" based on physiological observations were introduced in an effort to secure timely help for the critically ill the use of an early warning system has been proposed as a method of identifying patients at risk (Lee *et al*, 1995; Morgan *et al*, 1997; Stenhouse *et al*, 2000; Welch, 2000).

Early Warning Scoring systems are based upon the allocation of "*points"* to physiological observations, the calculation of a total "*score"* and the designation of an agreed calling "trigger" level. Some early warning systems use "*calling*" or referral criteria based upon routine observations, which are activated when one or more variables reach an extreme value outside the normal range (DoHMA, 2003). The use of physiological track and trigger warning tools seeks to enhance equity by giving:

- timely recognition of all patients with potential or established critical illness irrespective of their location;
- Timely attendance to all such patients, once identified, by those possessing appropriate skills, knowledge and experience.

It could be suggested that ward nurses are encouraged to be proactive as opposed to reactive, in trying to identify those at risk of deterioration. Patients are then scored, according to their physiological parameters (pulse, blood pressure, respiratory rate, urine output, temperature and sedation level). If a patient score is above a certain figure, usually referred to as a trigger, then nursing staff are instructed to inform the medical staff, and request that they come to review the patient.

Evidence suggests that basic observation of the patient's airway, breathing and circulation should form the main component of any warning system. Combining these simple observations with a measure of fluid balance and neurological status formed the basis of a simple system of early detection. EWS systems rely on the observation of the patient's vital signs and utilize specific calling criteria or a trigger score to decide on whether to summon medical or specialized assistance (Murch and Warren, 2001; Carberry, 2002).

The purpose of an EWS system is to provide staff with an aggregate physiological score generated from baseline recordings of vital signs. The greater the physiological deviation from the normal parameters, the higher the point scores. Clinical deterioration is subsequently detected and medical intervention can be implemented at an early stage in the patient's illness. Many physiological tracking and triggering systems have been developed and modified to enable early recognition and treatment of acutely ill patients (Appendix 1, 2 and 3). They may be classified as in Table 1.

However, any type of physiological tracking and triggering tool should be accompanied by an algorithm (Figure 1). The algorithm is the key element in ensuring an early response from the medical staff on duty. A trigger score means that the patient needs to be reviewed by the medical staff

urgently, within a few minutes (ALERT, 2000). Subsequent guidance suggests a safeguard of calling on senior medical staff assistance.

When a patient's observations reach a given trigger threshold, the action required of attending staff should be unambiguous. Such actions will depend on the availability and nature of a critical care outreach service. Some hospitals provide clear guidance for ward nurses authorising the initiation of investigations or basic interventions depending upon specific physiological observation(s).

Critical Care Outreach: Evidence

It is evident from the literature that there is a growing concern about the appropriate management of the acutely ill patients and the development of outreach critical care (Dove *et al*, 2001; Murch and Warren, 2001; Groom, *et al,* 2001; Subbe, *et al*, 2001; Woodrow, 2001; Sterling and Groba, 2002). Outreach was introduced in order to speed up the identification of sick patients on the ward and so facilitate timely medical intervention, which may avert critical care admissions. The document *The Nursing Contribution to the provision of Comprehensive Critical Care For Adults: A Strategic Programme of Action* states that future research for critical care should address formal evaluation of Early Warning Scores, and their impact on patient outcomes (DoH, 2001).

Hospitals are expected to examine the effects of outreach on outcomes such as length of stay on ICU, mortality on ICU, and readmission rates to critical care to see if there have been any significant reductions. Although there is not much published research on EWS effectiveness, the Department of Health (2001) recognised EWS Systems as useful adjuncts for ward nurses.

The National Outreach Forum subgroup members performed a telephone survey in relation to the use of track and trigger warning systems in the spring of 2003. Most units utilising track and trigger warning systems employed an aggregate weighted score model. The majority of responding hospitals had initiated their use of track and trigger warning since the publication of Comprehensive Critical Care (DoH, 2002).

All responding hospitals utilised respiratory rate, systolic blood pressure and heart rate as part of their track and trigger system. The majority also included assessment of level of consciousness, some measure of urine flow and temperature. A minority included oxygen saturation and pain as additional parameters. Supplementary scoring /trigger parameters including biochemical abnormalities and a Nurse Concern component are also included in some Trusts. The majority of respondents using track and trigger systems applied their system to all patients.

Stenhouse *et al* (2000) evaluates the introduction of a Modified Early Warning System (MEWS) on two general surgical wards over a 9 month period. In this period 206 patients were put onto the scoring system and of those 26 were admitted to ICU. The use of MEWS appears to lead to earlier referral to ICU. This is a relatively small study and does not state whether the patients monitored with MEWS had an improved outcome. Leary and Ridley's study (2003) suggests that no change could be detected in patterns of re-admission as a result of the introduction of an outreach team. The authors suggested that although outreach is an important development for critical care, its performance should not be measured by other parameters.

On the other hand, outreach care is a relatively new service, at some hospitals running for less than three years. Therefore, it might be too early to reach a conclusion about their efficacy in terms of patient outcome. This could be affected by the experience of the outreach team in providing critical care outside the critical care unit, or the reluctance of medical staff to acknowledge the wealth of knowledge that senior critical nurses could offer in identification of patients at risk of deterioration.

A descriptive study exploring nurses' experiences of calling for emergency assistance concluded that nurses continue to be unsure and under confident in this situation (Cioff, 2000). Intuitive feelings relating to the patient being "*not quite right*" or "*a gut feeling*", together with prior experiences, were major factors in the decision to seek assistance. This has been reflected in the recently revised Australian MET system call-out criteria, which now includes a specific criterion of "*worried about patient*". Other authors suggest the role of a critical liaison nurse specialist as an essential component of future service development (Murch and Warren, 2001).

Buist *et al's* study (2002) demonstrated a significant impact in reducing number of cardiac arrests and improving mortality following these cardiac arrests. This study has been criticized as there may have been other explanations for the improvement in outcome; for example, the outreach team may have increased "Do Not Resuscitate" orders, so avoiding pointless resuscitations.

Odell *et al* (2002) looked at the implementation of a EWS tool on surgical wards. It is suggested that this system was well received in the pilot area by both nursing and medical staff. Some nurses felt it both

empowered them and enabled them to vocalize their concerns for a patient with a language that is not subjective, but based on physiological parameters. They felt supported and reassured that the outreach system provided an alternative channel for communication to discuss their patients' care, and they were able to use the experience to learn from their patients' future care.

A significant number of hospitals have declared the use of a referral algorithm for use in conjunction with physiological track and trigger warning with the majority citing the parental medical team as the first point of referral for patients who trigger the system (National Outreach Survey, 2002). Many Trusts report evidence of the benefit of track and trigger warning systems, in improving single process steps in care of the critically ill.

- Improved frequency and quality of routine physiological observations.
- Reduced delay in admission to ICU from median 15.5 hrs on wards without MEWS track and trigger monitoring to 5.5 hrs on wards with the tool in use.
- Reduction in APACHE scores on admission to Critical Care .
- Reduction in length of stay on Medical Admissions Unit.
- Improved communications between health care professionals caring for sick patients.

An Observational study of an outreach service linked to four surgical wards in Leeds General Infirmary found unplanned transfers from the four wards to intensive care were significantly reduced, and ICU mortality significantly improved compared to a similar period before the service was introduced (Pittard, 2003). In addition, average length of stay decreased from 7.4 to 4.8 days. There were no significant changes in these measures for patients from wards not offered the service.

The Royal Free Hospital in London compared a year before and the year after introduction of an outreach service (Ball and Kirkby, in press. Cited in DoHMA, 2003). The service follows-up all discharges from critical care: 546 patients from July 2001 to February 2002. Hospital mortality significantly improved (14.7% from 22.7%), and re-admissions were reduced from 12.8% to 5.8%.

However, interpretation of the impact of critical care outreach must be undertaken with reference to the particular model and location of service under scrutiny. Leeds General Infirmary and Norfolk and Norwich University Hospital both reported services operating during normal working hours – with contrasting results, while the Royal Free Hospital outreach team works a twelve-hour daytime service, seven days a week (Pittard, 2003; Ball and Kirkby, in press; Leary and Ridley, 2003).

Conclusion

In acute care, growing attention has been given to the appropriate management of sick ward patients. Critical care often takes place outside ITU/HDU (Place and Cornock, 1997) and a number of published articles highlighted the need for critical care outreach (Mc Quillan *et al*, 1998; Goldhill *et al,* 1999; Mc Gloin *et al*, 1999). Critical care outreach services were launched and EWS were introduced, resulting in a significant change in practice. The Department of Health and Modernisation Agency, after careful review, has made the following observations (Table 2) in order to clarify general characteristics of the tools currently in use in the UK (DoHMA, 2003).

The National Outreach Survey (2002) showed that critical care outreach is delivered very variably across the UK. A significant number of Trusts offer critical care education for general ward staff as well as undertaking needs analysis and audit. Many hospitals employ EWS systems to assist in the timely identification and management of critically ill patients, but only a small minority of Trusts provide 24 hour bedside support while still engaging in education, audit, and use of track and trigger warning systems.

In conclusion, whilst supporting the development of outreach services and EWS tools, post-implementation audit, evaluation and local refinement of the selected track and trigger systems is essential. It is imperative that the future of any outreach service must be responsive to such evaluation. The next steps will be to build the evidence base and to look at the impact on improving patient care in terms of physical and emotional wellbeing, and clinical and cost effectiveness.

Table 1 Physiological track and trigger warning systems classification (DoHMA, 2003)

"Single parameter" systems (Appendix 1): ▪ Tracking: Periodic observation of selected basic vital signs. ▪ Trigger: One or more extreme observational values.
"Multiple parameter" systems (Appendix 2): ▪ Tracking: Periodic observation of selected basic vital signs. ▪ Trigger: Two or more extreme observational values.
"Aggregate weighted scoring" systems(Appendix 3): ▪ Tracking: Periodic observation of selected basic vital signs and the assignment of weighted scores to physiological values with calculation of a total score. ▪ Trigger: Achieving a previously agreed trigger threshold with the total score.

Table 2 General Characteristics of Early Warning Tools (DoHMA, 2003)

Physiological track and trigger warning systems are: **Not** substitutes for clinical judgment. **Not** predictors of the inevitable development of critical illness. **Not** predictors of overall outcome from critical illness. **Not** comprehensive clinical assessment tools. **Not** indicators for immediate admission to ICU or HDU. **Physiological track and trigger warning systems:** **Are** aids to good clinical judgment **Are** '*red flag*' markers of potential or established critical illness. **Are** generally sensitive depending upon their complexity. **Are** aids to effective communication in care of the critically ill and a means of securing appropriate help for sick patients. **Are** indicators of physiological competence. **Are** indicators of physiological trends. **Are** valuable even in the absence of a formal critical care outreach service.

Appendix 1

Single Parameter Track and Trigger Warning System

The Princess Alexandra Hospital NHS Trust Critical Care Outreach Team Patient Assessment using the HOT (Harlow Outreach Team) Tool

A patient, who fulfils any one or more of the criteria below or is causing concern, needs urgent intervention.

BREATHING
Respiratory rate of less than 8 or greater than 25/min
Oxygen saturation less than 90% despite oxygen
PaO2 of less than 8 kPa on an arterial blood gas sample despite oxygen

CIRCULATION
Pulse of less than 45 or greater than 125/min
Systolic blood pressure of less than 90 or greater than 200 mmHg, or a sustained fall of greater than 40 mmHg from patient's normal value
pH of less than 7.3
Base Excess of lower than –7 mmol/l

RENAL
Urine output less than 30 ml/hr for 3 consecutive hours
Evidence of deteriorating renal function

CONSCIOUS LEVEL
Patient does not respond to voice
Glasgow Coma Score of 8 or less

OR

Patient looks unwell or you feel worried about their clinical condition
Care of all patients remains the responsibility of the admitting team

Phone 2222 and ask for the Critical Care Outreach Team
Contact: Sarah Starr, Nurse Consultant Critical Care, Princess Alexandra Hospital NHS Trust, Hamstel Road, Harlow, CM20 1QX, Tel: 01279 827251. E-mail: sarah.starr@pah.nhs.uk

Appendix 2
Multiple Parameter System
Barking, Havering & Redbridge NHS Trust S.E.C.S. (System for Evaluating Critically Sick)

Systolic Blood Pressure	<101	>200
Respiratory Rate	<9	>20
Heart Rate	<51	>110
Saturation (room air)	<90%	
Urine output	<1ml/kg/2 hours	
Conscious level	Not fully alert	

If a patient fulfils **two** or **more** of the above criteria **OR** you are worried about their condition **BLEEP** the **Registrar** from the admitting team and the **Outreach Sister** (899)

These two parties **MUST** review the patient within **thirty minutes**
Contact: Dr. Peter Walker, Consultant Intensivist, Anaesthetic Department,
Barking, Havering and Redbridge NHS Trust. Tel: 017708 708443

Appendix 3

The Modified Early Warning Score (MEWS) Tool

MEWS Score Table Queens Hospital, Burton Hospitals NHS Trust

Score	**3**	**2**	**1**	**0**	**1**	**2**	**3**
RR		<8		9-14	15-20	21-29	>30
HR		<40	40-50	51-100	101-110	111-129	>130
BP	<45%	<30%	<15%	Normal For Patient	>15%	>30%	>45%
CNS				Alert	Responds to Voice	Responds to pain	Un-responsive
TEMP		<35.0		35–38.4		>38.4	
URINE		<0.5 ml/kg/hr	<1 ml/kg/hr		>3 ml/kg/hr		

Trigger level – score 4 for surgical patients, with an adjustment for medical patients

Contact: Sandra Coates, Nurse Consultant, Intensive Care Department, Queens Hospital, Burton Hospitals NHS Trust, Belvedere Road, Burton On Trent. Staffs. DE13 ORB.

* In theory aggregate scoring systems may not trigger in the event of an isolated variable only falling outside the scoring range (e.g. MEWS would not trigger with respiratory rate of less than 8 in the absence of any other physiological derangement). Thus far this theoretical consideration has not been reported as a practical problem.

Figure 1 Referral algorithm example
Doncaster Royal Infirmary

Score is greater than 0:	Inform a trained nurse
Score is 1–3:	Increase frequency of pt obs to at least 4 hourly
Score is 3 in one category:	Nurse should contact HO/SHO for immediate patient review and increase frequency of patient observations
Score total is greater than 3:	Nurse should contact HO/SHO for patient review within 30 mins and increase frequency of patient observations Doctor should seek senior advice as needed from Parent Team Registrar and/or Consultant
Score total is greater than 6:	The Parent Team Registrar should be involved in immediately reviewing the patient and consider: Discuss with own Consultant, Contact CCLT if appropriate.

If at any time there is no response from the parent medical team in terms of action taken or if the patient's condition does not improve within 2 hours the next most senior doctor must be contacted.

If unsure about the Early Warning Score, or concerned about any patient at any time please contact The Critical Care Liaison Team – Bleep 980

Contact: Dr David Wood, Lead Consultant – Critical Care, Intensive Care Unit, Doncaster Royal Infirmary, Doncaster and Bassetlaw Hopsitals NHS Trust, Armthorpe Road, Doncaster, DN2 5LT, Tel: 01302 366666 bleep 448

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