

# RECOGNISING AND RESPONDING TO CLINICAL DETERIORATION: BACKGROUND PAPER

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## 1. INTRODUCTION

The characteristics of patients in Australia and internationally are changing. Acute care hospitals now have an increasing proportion of patients with complex problems who are more likely to be or become seriously ill during their hospital stay (2, 3). Warning signs often precede serious adverse events such as unexpected death, cardiac arrest and unplanned admission to intensive care units (4, 5). However, there is consistent evidence that these warning signs are not always identified; and if they are, they may not be acted on (6).

Ensuring that patients who deteriorate in hospitals receive appropriate and timely care is a key safety and quality challenge. All patients should receive the same level of comprehensive care irrespective of their location in the hospital or the time of day. However survival rates from cardiac arrest are lower on weekends and at night, and mortality rates of patients admitted to intensive care from general wards are higher than those admitted from emergency departments or operating theatres, suggesting that these patients are not receiving optimal care prior to their admission (7, 8).

This situation has been known for some time, and there has been considerable work done over almost 20 years to improve the care that patients who are deteriorating receive. Nonetheless, problems remain. These problems can be seen in the media reports that appear when individuals die unexpectedly in hospitals, research showing the continuing occurrence of avoidable cardiac arrests, and reports of serious and sentinel events (Box 1) (1, 9-11). One study has identified that 4.5% of hospital patients meet criteria that

**Box 1: Examples of sentinel events involving patients at risk of acute deterioration reported by New Zealand District Health Boards (1)**

- Patient admitted with pneumonia. Became short of breath and had low oxygen levels. Staff did not call for assistance in a timely way. The patient died.
- Patient admitted from nursing home with blood clot on the brain. Hourly neurological observations ordered but not done. Patient was found dead three hours after last observation.
- Nurse tried for one a half hours to get patient reviewed by surgical team. Patient transferred to ICU and subsequently died. Seriousness of patient's condition not communicated to team.

indicated some level of clinical deterioration (12).

The factors that contribute to a failure to recognise and respond appropriately to clinical deterioration are complex and overlapping. They include issues regarding knowledge and skills of staff, the way in which care is delivered, organisational systems, attitudes and communication of information (13). All of these factors need to be addressed for patients who deteriorate to consistently receive safe and high quality care.

This program is the Commission's response to the problem of ensuring that patients who deteriorate are recognised and responded to appropriately. The Commission is not in a position to address all of the factors that contribute to failures in this area, and the initiatives included here have been identified as areas where the Commission can use its position as a national leader in safety and quality in Australia to advance this area of work. The main initiatives in this program are the development of:

1. a consensus statement setting out the essential elements for recognising and responding to patients who deteriorate
2. guidelines applying the essential elements in specific settings, namely paediatrics, mental health and in smaller facilities with no intensive care or limited medical cover
3. guidelines for implementing programs to improve the recognition of and response to clinical deterioration
4. an evidence-based adult general observation chart that supports recognition of deterioration and prompts action.

This background paper provides an overview of the current state of work in this area, looking particularly at the evidence regarding, and systems for both the recognition of and response to deterioration.

## **2. CHANGES IN VITAL SIGNS AND SERIOUS ADVERSE EVENTS**

Research has consistently shown that there are observable physiological abnormalities prior to adverse events such as cardiac arrest, unanticipated admissions to intensive care and unexpected death (4, 5, 14-16). Abnormalities in vital signs such as blood pressure, consciousness, respiratory rate, heart rate, and oxygen saturation are common prior to the occurrence of these serious adverse events.

For example, one study found that among patients without a "Do Not Resuscitate" order who died in hospital, approximately one half had serious vital sign abnormalities (such as abnormal blood pressure, respiratory rate and heart rate) documented in the eight hours before death, almost half had documented abnormalities between 8 and 48 hours before death and almost one third had abnormalities in the entire 48 hour period prior to death (5).

Despite their importance as possible predictors of clinical deterioration or serious adverse events, these vital signs are not always measured, recorded or acted on. One study found that the frequency of documented observations prior to a cardiac arrest varied considerably between patients, and that only their pulse rate and blood pressure were recorded more than once in 24 hours (17). In another study vital signs were measured by study personnel (14). If abnormal vital signs were found, nurses were informed of the results and asked questions to identify whether they were aware of the abnormal results. Abnormal vital signs were identified by the study team for 18% of patients and in over 40% of these cases nurses were

unaware of the abnormalities. An evaluation of the implementation of medical emergency teams in Australia found that even when there were documented physiological abnormalities and the criteria for calling the medical emergency team were met, the team was called for only 30% of patients prior to their unplanned admission to ICU (6).

The existence of observable signs of deterioration prior to an adverse event provides the impetus to put systems in place to identify this early deterioration and attempt to prevent any possible later adverse events.

### 3. SYSTEMS FOR RECOGNISING AND RESPONDING TO CLINICAL DETERIORATION

The factors that contribute to a failure to recognise and respond to a deteriorating patient are complex and overlapping. Issues that have been identified include (5, 15, 18-22):

- not monitoring vital signs consistently or detecting changes in vital signs
- lack of knowledge of signs and symptoms that could signal deterioration
- failing to recognise the significance of apparent deterioration
- uncertainty about whether assistance should be called
- delays in notifying medical staff of the signs of deterioration
- delays by medical staff in responding to such notification
- lack of skills and knowledge about managing deteriorating patients among ward medical and nursing staff
- failure of ward staff to promptly seek supervision or advice
- failure to communicate with other staff about concerns, including in handover situations
- failure of essential equipment
- lack of clarity about roles and responsibilities for care of deteriorating patients.

Systems have been developed to address these issues and provide a framework for dealing with patients who deteriorate in hospitals. The generic term “rapid response system” is often used to describe these systems. A rapid response system includes a mechanism for identifying warning signs that may signal deterioration early, processes for responding to these signs quickly to prevent further deterioration or events, and having supports in place to ensure that the system is accepted and embedded within the health care facility.

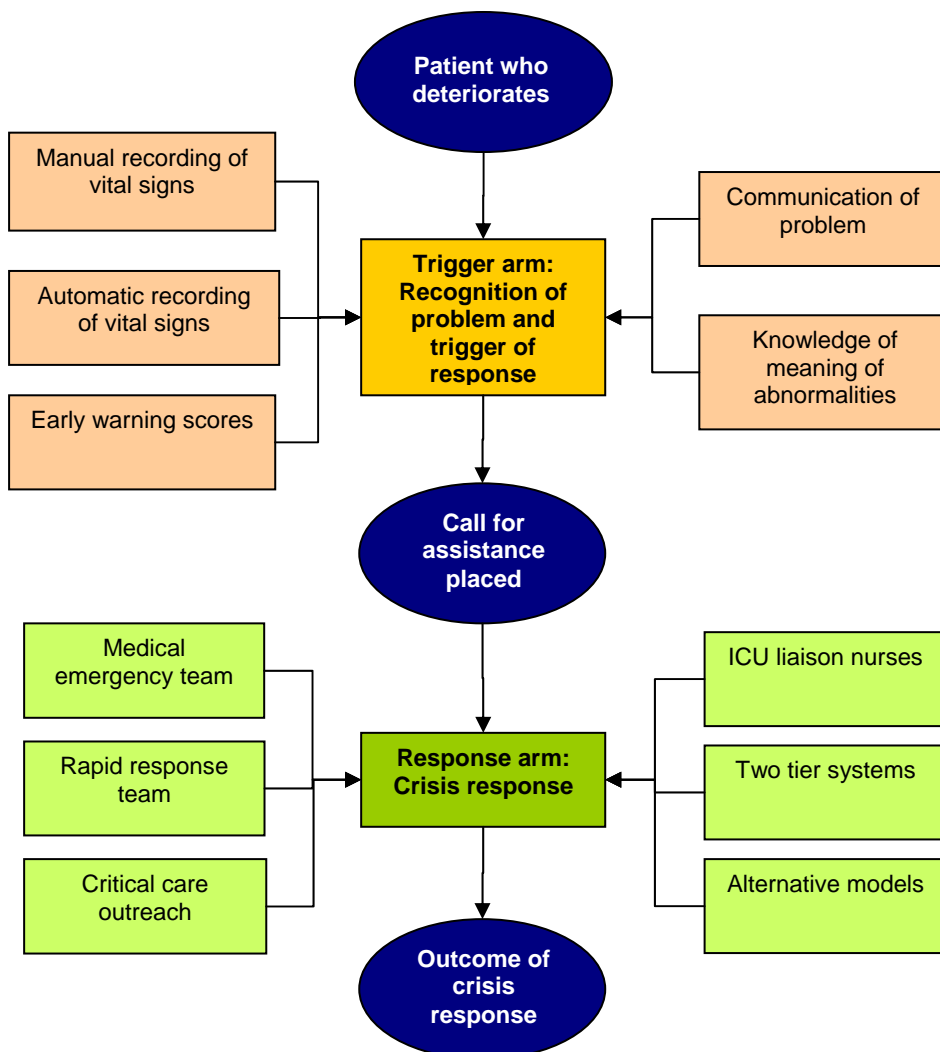
There are four essential features of a rapid response system (23, 24):

1. *Event recognition and response trigger*: this arm of a rapid response system is needed to detect patients who are deteriorating and trigger a response. Aspects of this arm include processes for monitoring vital signs, the criteria for triggering a response and the mechanism for triggering the response.
2. *Crisis response*: this arm of a rapid response system provides personnel and equipment resources to address the needs of critically ill patients in a timely way.

3. *Process improvement*: this arm of a rapid response system establishes mechanisms to collect data and provide feedback to providers, planners, patients and families to improve responses and contribute to prevention of future events.
4. *Administration*: an administrative structure is required to coordinate these activities. Aspects of this arm include provision of adequate resources, education and training of staff and processes to support the ongoing culture within the organisation to support the system.

The process improvement and administration arms of a rapid response system are essential to ensure that the rapid response system is sustainable, and that the use of a rapid response system contributes to improved performance. Much of the research and discussion about rapid response systems focuses on the trigger and response arms. These processes, and many of the issues that have been discussed regarding them, are summarised in Figure 1. The trigger and response arms of a rapid response system are discussed in more detail in the next two sections of this paper.

**Figure 1: Overview of trigger and response arms of a rapid response system**



## 4. THE TRIGGER ARM: RECOGNISING DETERIORATION

The major components of this arm of a rapid response system are:

- processes for monitoring vital signs
- what criteria need to be met, including changes to vital signs, before assistance is sought
- how the call for assistance is made.

These issues are discussed further in this section.

### Observation charts and recording vital signs

One of the factors that can contribute both to poor recording of observations and failure to interpret them correctly is the way in which observation charts are designed and used.

There has been little research on this issue. One study from the United Kingdom examined five different charts used within one hospital and found that the design of the charts had a significant effect on the ability of medical and nursing staff to detect patient deterioration, with detection rates for parameters showing deterioration ranging from 0% to 100% (25). Based on this analysis a new chart was designed, and significant improvements were found in detection rates of parameters that were poorly identified initially, with rates of detection of abnormalities in respiratory rate and oxygenation increasing by 41% and 45% respectively.

There is currently work underway in a number of Australian jurisdictions, as well as individual hospitals and health services, to improve observation charts.

### Use of technology to record observations and trigger a response

Systems have been developed in Australia (Patientrack™) and the United Kingdom (VitalPAC™) that allow nurses to directly record physiological observations into a personal digital assistant (PDA) (26, 27). An evaluation of VitalPAC found that recording vital signs electronically was quicker, preferred by nurses and less errors were made compared to using pen and paper (28). Both of these systems are able to send out alerts to medical staff based on the vital signs recorded, and Patientrack can escalate these alerts until a response is received (27, 29).

There has been limited use of these technological solutions to date, and limited evidence as to their utility in improving the identification of patients at risk. VitalPAC has been successfully trialled in Portsmouth Hospital, and is now being used in other hospitals in the UK (29, 30). A trial of Patientrack was conducted by the Central Manchester and Manchester Children's Hospitals NHS Trust in the UK in 2008 (31). Preliminary reports suggest that it has been positively received (32).

There are now new systems being developed that monitor vital signs such as heart and respiratory rate automatically on general wards (33, 34). Such systems do not require nurses to record observations either onto observation charts or into PDAs. It is likely that this automatic measurement of vital signs would assist with the identification of patients at risk.

### Early warning systems

Early warning, or "track and trigger" systems are structured processes for measuring basic vital signs and acting on the results. Once a predetermined criterion is reached (the trigger)

an action should be initiated (35). In most cases early warning systems are based on routine physiological monitoring conducted nurses on a ward to reduce the burden of additional collection of information. The criteria for calling a medical emergency or similar team would be considered as a simple early warning system (see Box 2, page 8 for an example of these criteria).

Early warning systems are widely used and there are a large number of different systems in place (36). These systems vary in terms of the vital signs that are measured, the weighting of these measures, the way the measures are combined and the cut-off criteria used to trigger an action (27).

Two recent systematic reviews have concluded that the performance of most early warning systems is poor and that they lack evidence of reliability, validity and utility (27, 35). Despite this lack of evidence, guidelines from the National Institute for Health and Clinical Excellence (NICE) in the United Kingdom recommended that physiological track and trigger systems should be used to monitor *all* adult patients in acute hospital settings (36). This recommendation was made because there is evidence that early warning systems increase attention to regular observations.

## Role of education

One of the factors that can contribute to the failure of staff to act on observed changes in vital signs is that they are not aware that the changes may be indicative of clinical deterioration. Early warning systems and automatic triggers are designed to remove reliance on individual decision making. However their poor sensitivity suggests that they cannot be relied on alone (35).

Education is frequently part of efforts to implement a rapid response system, and can cover both knowledge of vital signs and identification of patients at risk, as well as how they should be managed. Portsmouth Hospital in the United Kingdom has addressed this issue by establishing a stand-alone course designed to improve confidence and ability in the recognition and management of adult patients with impending or established critical illness (37). Evaluations have found that attendance at the course increased knowledge of attendees about basic aspects of acute care, as well as increasing confidence about the management of acutely ill patients (38, 39). There are also a number of similar courses that have been developed in Australia, including the Recognition and Management of Acute Conditions Program at St George Hospital and the Compass Program in the ACT.

## Calling emergency assistance

The process of calling for emergency assistance is not always straightforward (6). Some studies have looked at this communication process in detail and examined the factors that are associated with decisions to call or not call for assistance. These include (18, 40):

- nurses feeling uncertain about whether they are doing the right thing in calling the medical emergency team
- nervousness and anxiety about calling the medical emergency team, including concern about “feeling like an idiot” if the call is a false alarm
- seeking input from peers and more senior colleagues about whether a call is necessary

- a desire to deal with the identified problem by ward staff, potentially leading to a critical delay in required treatment
- high workload and busyness decreasing time to think about the implications of the vital signs observed.

These factors indicate that the process of activating a trigger in a rapid response team is not straightforward. Even if there is a robust system in place there will always be a range of organisational, cultural and individual factors that influence how it will be used.

## Summary

Some of the issues that remain unresolved regarding the recognition of patients who are deteriorating include:

- the design of observation charts that improve monitoring of vital signs
- the effectiveness of technological options for recording vital signs and triggering alerts for assistance
- the sensitivity and specificity of early warning systems
- how staff should be trained in identifying (and managing) clinical deterioration
- organisational systems that are needed to support the use of tools to identify patients who are deteriorating.

The trigger arm of a rapid response system is also reliant on basic processes regarding the way in which care is delivered, observations monitored and information communicated to other staff. For example, the Productive Ward program developed by the National Health Service Institute for Innovation and Improvement to increase the time ward staff spend on direct patient care includes modules covering both patient observations and communication during handover (41). These basic clinical procedures will have an impact on the identification of clinical deterioration, and similar programs are also being introduced in Australia.

## 5. THE RESPONSE ARM: RESPONDING TO CLINICAL DETERIORATION

There are a number of different models in place for the response arm of rapid response systems. These vary mainly in terms of the composition of the teams responding to the patient who is deteriorating (led by doctors or led by nurses), the skills of the responding team (for example whether the team is able to intubate patients) and the role of the responding team (some teams have a structured educative role as well as responding to an immediate clinical need). At this stage there are no studies that demonstrate any difference in outcomes between these approaches (23). The different models that have been developed reflect the different circumstances of organisations, particularly in terms of issues such as workforce and staffing mix.

The most common models for rapid response teams are summarised in this section.

## Medical emergency team

The first country to take a systematic approach to dealing with patients at risk in hospitals was Australia. The medical emergency team (MET) was developed at Liverpool Hospital in Sydney and first introduced in 1990 (42). The purpose of the MET was to supersede the existing cardiac arrest team, and it was based on the principles of early recognition and rapid response to manage severe trauma.

Following its introduction at Liverpool the use of a MET spread rapidly, and by 2005 approximately 60% of hospitals in Australia and New Zealand with an intensive care unit had a MET service in place (43). Generally these services were introduced prior to the publication of studies of the effectiveness of MET services, and were in response to reports about dealing with adverse events (43).

While the composition of a MET service can vary, they generally include an intensive care physician, nurse and possibly other medical or nursing staff. The MET service can be called by any staff member in the hospital, and in some hospitals they can also be called by patients and families (44). Again, while the criteria for calling the MET can vary, in Australia they are generally as illustrated in Box 2 (6).

## Rapid response team

The terms “rapid response team” and “medical emergency team” tend to be used interchangeably in Australia, however in the United States rapid response teams tend to refer to nurse-led teams (23). Rapid response teams have been implemented widely in the United States as part of the Institute for Health Improvement’s 100,000 Lives Campaign (24), (45). One study from the United States reported on a rapid response team led by a physician’s assistant that included a critical care nurse and a respiratory therapist. Similar results to studies of medical emergency teams were found for this rapid response team in terms of decreased rates of cardiac arrest (46).

## Critical care outreach

Critical care outreach teams have been primarily established in United Kingdom. There is considerable variation among these critical care outreach teams, however they are generally led by ICU nurses, sometimes with medical input (23, 47). The role of critical care outreach teams varies, but generally includes (47):

- provision of critical care services to patients on general wards
- follow up of patients from ICU
- formal and informal education of ward staff
- audit and evaluation of outreach activity.

### Box 2: Calling criteria for medical emergency teams widely used in Australia

#### *Airway*

If threatened

#### *Breathing*

All respiratory arrests

Respiratory rate < 5 breaths per minute

Respiratory rate > 36 breaths per minute

#### *Circulation*

All cardiac arrests

Pulse rate <40 beats per minute

Pulse rate >140 beats per minute

Systolic blood pressure < 90 mm Hg

#### *Neurology*

Sudden fall in level of consciousness (fall in Glasgow coma scale of >2 points)

Repeated or extended seizures

#### *Other*

Any patient you are seriously worried about that does not fit the above criteria



## Intensive care unit liaison nurse

The use of intensive care unit liaison nurses are increasing in Australia as another way of responding to clinical deterioration. This model overlaps with the UK critical care outreach team in that it is a nursing role that is involved in staff education and support, ward assessment and liaison, patient care and support and family education and support (48). In some cases the ICU liaison nurse is used together with a medical emergency team (49).

## Two-tier models

Another model that is used to meet the needs of patients who deteriorate has two tiers: the first tier involves a call to a member of the primary care team; if there is no response or further help is required a second call is made to a medical emergency team or other ICU based service. The rationale that is often provided for this approach is that it is more appropriate that emergency care is provided by the primary care team who know the patient, however concerns have been raised that this approach could embed the problems that led to the initial development of models such as MET.

## Alternative models

The models described here of the different forms of rapid response teams usually include either nursing or medical staff from an intensive care unit. However this model is not necessarily practical in rural and remote areas where ICU services are limited or not available.

One Australian hospital has described the successful implementation of a rapid response system using staff from the emergency department, and others have reported the introduction of a rapid response systems in smaller hospitals (46, 50, 51). However despite these reports there has been little specific attention paid to the needs of rural and remote areas.

This problem is not limited to rapid response systems. There is an increasing focus on the specific strategies that are needed to support critical care services more broadly in rural areas (52, 53).

Staffing and skill mix are the main issues that affect the way in which acute deterioration can be managed in rural and remote health facilities (54). Sometimes care is provided by short-term medical locums, and in other cases nurses are the main providers of care. It is important that staff have the skills and authority to deliver care to deteriorating patients until further assistance is available.

In Canada work is underway to identify critical care models that can be applied in smaller hospitals (55). Information about the success of these models is not yet available, however given the geographic similarities between the two countries, they may be useful for Australia to consider.

## Summary

Different response models have developed over time to meet the varying needs of health care organisations. However there has been limited work done regarding an appropriate model for the response arm of a rapid response system in facilities without an ICU, particularly those in rural and remote areas. The nature of the trigger arm of a rapid response

system is probably less likely to change according to geographic location: appropriate monitoring of vital signs and recognition of deterioration should always occur. However geographic location does have an impact of staffing levels and staffing mix, as well as the skills and expertise of staff. These factors have an influence on the way a rapid response system is established and how it should operate in an ongoing way.

## **6. EVIDENCE FOR EFFECTIVENESS OF RAPID RESPONSE SYSTEMS**

There have been numerous studies published about the effect of rapid response systems. Most of these studies have looked at the impact of the introduction of rapid response systems on events such as cardiac arrests, unexpected deaths and unplanned admissions to ICU, using a before and after design (49, 56-64). Generally the introduction of a rapid response system has been found to be beneficial in terms of reduced deaths, cardiac arrests, hospital length of stay, ICU length of stay and cost (23).

Only two randomised controlled trials of the introduction of rapid response systems have been published (6, 65). One Australian study found no difference between hospitals randomised to introduce a MET service and controls in terms of rates of cardiac arrest, unplanned admission or unexpected death (6). The other study involved the introduction of a critical care outreach team at ward level in a single hospital in the UK (65). This study found a reduction in hospital mortality for patients in the intervention wards.

Three systematic reviews of rapid response systems have concluded that there is insufficient evidence to conclusively state that rapid response systems are effective (66-68). The reasons for this conclusion are associated with the fact that most of the studies that have found improvements associated with the implementation of a rapid response system are uncontrolled before and after studies that are not as methodologically strong as randomised controlled trials.

Despite these findings, there is a consensus emerging that the evidence that exists is sufficient to support the use of rapid response systems, particularly given the face validity of the concept, lack of adverse outcomes and modest cost implications (23, 69).

## **7. PROMOTION OF RAPID RESPONSE SYSTEMS**

Much of the development of rapid response systems has come from bottom up processes within individual hospitals. However there is an increasing move towards their systematic promotion and implementation by health departments and other institutions that support safety and quality. International and Australian initiatives to introduce rapid response systems are described in this section.

### **International initiatives**

In the United Kingdom the Department of Health provided funding to establish critical care outreach services in hospitals in response to a review of critical care services in 2000. The primary aim of these systems was to develop services to support critically ill patients

throughout the hospital (70). A national survey of critical care outreach services in England in 2005 found 73% of responding hospitals had a formal critical care outreach service (47). National Health Service trusts had been encouraged to develop outreach services to meet local needs, and accordingly there was wide variation in the way in which the outreach service was delivered (47, 71).

Another initiative in the United Kingdom is the Hospital at Night Program, introduced by the National Health Service in 2004 in response to limitations on working hours for junior doctors. The main component of the program is the use of multi-disciplinary teams that are able to meet the immediate needs of patients at night (72).

The implementation of rapid response teams in the United States was one of six interventions promoted by the Institute for Health Improvement (IHI) as part of their 100,000 Lives Campaign, and was also included in their follow up 5 Million Lives Campaign, launched in December 2006 (73). As part of this campaign materials have been developed to assist hospitals put a rapid response team in place. The IHI currently has over 4,000 hospitals enrolled in the 5 Million Lives Campaign, although it does not report how many are implementing the specific components of the campaign, such as rapid response teams.

In Canada, a Critical Care Strategy was launched by the Ontario Ministry of Health and Long-Term Care in January 2006 (74). One initiative in this strategy is the implementation of critical care response teams. The implementation of this strategy involved the provision of funding to hospitals to establish critical care response teams, as well as staff training, expert advice, ongoing facilitation and communication, and the provision of tools and materials (55).

Response to the deteriorating patient has been identified by the WHO as a possible additional patient safety solution to add to the existing nine solutions (75). The final solutions have not yet been released, however draft material circulated as part of the development of the solution suggests that the strategies to be put forward will align closely with the components of the rapid response system discussed earlier (21).

in 2008 the Joint Commission included a new National Patient Safety Goal that is linked to a rapid response system (76). The goal is to: "Improve recognition and response to changes in a patient's condition", and organisations are required to select "a suitable method that enables health care staff members to directly request additional assistance from a specially trained individual(s) when the patient's condition appears to be worsening".

### **Australian initiatives**

The only national initiative in Australia to promote the use of rapid response system was part of the Safer Systems – Saving Lives (SSSL) program coordinated by the Victorian Department of Human Services and funded by the former Australian Council on Safety and Quality in Health Care. The SSSL program was based on the IHI's 100,000 Lives Campaign and adapted their materials to promote rapid response systems and other initiatives in Australia. It also involved data collection by participating sites of outcomes measures related to each component of the SSSL program, including measuring outcomes of the implementation of rapid response systems. The SSSL program appeared to increase the uptake of rapid response systems in participating hospitals and there was some evidence that there was a reduction in adverse events such as cardiac arrests where this data was recorded. However implementation of the program was inconsistent, and the sustainability of the initiatives included in the program uncertain.

Some jurisdictions are currently looking at how they can improve the recognition and management of patients at risk of acute deterioration.

In NSW the Clinical Excellence Commission has undertaken a project, *Between the Flags*, to examine factors that contribute to the failure to identify patients at risk, and trial solutions to these problems (77). This project made a number of recommendations relating to the management and escalation of care for the deteriorating patient. These cover (78):

- early identification of at risk patients
- escalation protocols and rapid response systems
- education and training
- data collection
- communication at clinical handover
- executive and clinical buy-in
- evaluation.

The Patient Safety Centre in Queensland has recently developed a technical discussion paper regarding the recognition and management of deteriorating patients. This will be the basis of a state wide program that will commence in 2009.

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