Value of improving patient safety: Health-economic considerations for Rapid Response Systems – a Rapid Review of the Literature and Expert Round Table

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Title

The value of improving patient safety: Health-economic considerations for Rapid Response Systems – a Rapid Review of the Literature and Expert Round Table

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Keywords

Economics, patient safety, risk management, hospital rapid response team, Value-Based Purchasing

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Abstract

Objectives

Failure to rescue deteriorating patients in hospital is a well-researched topic. We aimed to explore the impact of safer care on health-economic considerations for clinicians, providers and policy makers.

Design

We undertook a rapid review of the available literature and convened a round table of international specialists in the field including experts on health economics and value-based healthcare to better understand health economics of clinical deterioration and impact of systems to reduce failure to rescue.

Results

Only a limited number of publications has examined the health-economic impact of failure to rescue. Literature examining this topic lacked detail and we identified no publications on long-term cost outside the hospital following a deterioration event. The recent pandemic has added limited literature on prevention of deterioration in the patients' home.

Cost-effectiveness and cost-efficiency are dependent on broader system effects of adverse events. We suggest to include the care needs beyond the hospital and loss of income of patients and/or their informal carers as well as sickness of healthcare staff exposed to serious adverse in the analysis of adverse events. They are likely to have a larger health-economic impact then the direct attributable cost of the hospital admission of the patient suffering the adverse event. Premorbid status of a patient is a major confounder for health-economic considerations.

Conclusion

In order to optimise health at the population level, we must limit long-term effects of adverse events through improvement of our ability to rapidly recognise and respond to acute illness and worsening chronic illness both in the home and the hospital.

Strengths and limitations of this study

- Frist comprehensive exploration of health economic aspects of a widely used safety intervention.
- Limited literature specific to the field was identified.
- The expert panel had the broad range of experience and skills required to apply the health economic methodology to the subject in question.
- Experimental data is not available.

Keywords

Economics, patient safety, risk management, hospital rapid response team, Value-Based Purchasing

INTRODUCTION

Over-, under- and mis-treatment of patients with complex needs are causes of significant harm to those individuals and a major source of global burden of disease(1). Patient harm add considerable costs to healthcare systems: 15% of hospital costs are considered to be linked to treatment of safety failures(1,2). Moreover, the numbers of older, frail patients and others with multiple conditions are growing year on year.

Harm through missed opportunities to identify or act on indicators of catastrophic deterioration such as abnormal vital signs (e.g., rapid breathing, low blood pressure) are common causes of serious adverse events in these patients(3) and have been called "Failures to rescue,". However, earlier recognition and more timely response to deterioration can save lives - and might improve the cost-effectiveness of service delivery: Interventions to detect deterioration in the community and hospital such as continuous vital sign monitoring systems, rapid response systems(4), rapid response teams, and enhanced care areas have been propagated and implemented increasingly in clinical practice(5). Evaluations of these services usually centre on clinical outcomes and measures of quality of life, but at present there is relatively little published work and no consensus about which financial metrics could usefully be employed(6), and how their value should be assessed.

In 2007 the Organisation of Economic Cooperation and Development (OECD) defined a range of patient safety indicators(7), these included hospital acquired infections, pressure ulcers and a range of complications of surgical and obstetric procedures. The 2017 OECD report on the economics of patient safety(8) made a recommendation to strengthen a value-based approach to reducing patient harm at national levels. It identified a range of system, organisational and clinical level interventions with strong themes around standards, protocols, checklists and information technology.

The majority of health economic evaluations of interventions to improve patient safety have focused on health care related infections and medication errors(9). Many have methodological limitations, however, by not having performed cost-benefit, cost-utility or cost-effectiveness or by adopting narrow cost perspectives, such as assessing segments of the whole system i.e. primary or secondary care(9) or litigation(10). There are challenges caused by costs being concealed within the systems of 'for-profit' organisations(11), and the

issue of whether evaluations need to reflect the public discourse whereby the value of identified individual lives seems to differ from that of statistical lives(12).

The aim of this paper is to understand the value of Rapid Response Systems. For this we examined the following questions:

1. What is the evidence from the published literature examining the health economic value of Rapid Response Systems?
2. What are the health economic principles required to describe the value of Rapid Response Systems?
3. How do these principles translate to the practice of clinicians, service managers and policy makers?

METHODS

The present paper has three parts: We undertook a rapid literature review to screen the peer reviewed literature. Having identified limited published evidence, we convened a round table to supplement the evidence with a catalogue of principles of health economics applicable to the research question. These principles were then illustrated by a hypothetical case study using scenarios with early and late detection to explore the possible impact of these on the identified catalogue on the value of care.

Rapid literature review

We undertook at rapid review(13) of the peer-reviewed literature concerning the health economics of Rapid Response Systems. We used MESH headings to gain the broadest possible perspective. (("Health Care Economics and Organizations"[Mesh]) AND "Hospital Rapid Response Team"[Mesh]). Terms of a more detailed search are included in appendix 1 to this manuscript. We included studies describing Rapid Response Systems for adults and children in hospitals limited to English language publications. References of these were snowballed. We excluded letters, editorials and studies that did not report health economic metrics as part of their primary or secondary outcome measures. The methodology for rapid reviews has been described elsewhere, and was chosen – in line with recommendations(14) – for this research as we expected to identify only few relevant

publications. Identified abstracts were classified each by a single reviewer (CPS,RS) using the online review-engine Ryyan and discussed where in doubt with the other reviewer.

The literature review was complemented by more recent insights from the care of patients with COVID-19 and the novel usage of monitoring technology in their care.

Expert round table

Expert round tables can be used to supplement scarcity of objective evidence(14–16). We hosted a two-day workshop at Beaumaris, North Wales in February 2020, with a group of clinical specialists, health service researchers, health economists and policy experts. The faculty is listed in appendix 2. Faculty was briefed about the research question and possible scenarios prior to the roundtable. A selection of relevant peer reviewed papers about both the health economic principles and results of the Rapid Review of the literature were disseminated through a joint online resource prior to the workshop. During the workshop we first catalogued principles of health economics using lenses from economic theory and healthcare management including the rules of value-based healthcare(17). These were then applied to the processes of patient safety in general and specifically reliable recognition and response to deterioration and finally illustrated with a case study.

Applied case study

We illustrated the principles identified in the literature review and expert round table through a fictious case-study based on a set of similar scenarios from the Nightingale programme(18). Nightingale is a European Horizon 2020 procurement grant that invited industry partners to submit technology for earlier detection of deterioration with continuous monitoring of vital signs. The Nightingale programme used four examples of deterioration illustrating the impact of care with and without improved monitoring. Examples included a patient with pancreatic cancer and a patient with a benign liver tumour both undergoing surgery and a patient being monitored for dangerous cardiac arrhythmias and a deteriorating chest infection

Patient and public involvement

There was no patient and public involvement as part of this study.

RESULTS

Summary of the rapid literature review

The search was undertaken on the 27th of February 2021 and repeated on the 24th of October 2021 and 20th December of 2022. After snowballing and searches of the grey literature we identified 120 papers, of these eight were included in this review:

Pappas(19) examined the effects of an electronic platform on the number of patients requiring escalation of care from a general ward to intensive care. No control group without Rapid Response System was provided. Hatlem(20) reported on a reduction in utilization of Intensive Care beds following the introduction of the Rapid Response Team but comparator groups were not matched.

In a paediatric population Bonafide(21) compared the cost of unplanned and planned intensive care admissions and concluded that a modest reduction of unplanned admissions could plausibly result in a cost-reduction for hospital care. Cardona(22) examined in an observational cost-analysis only the cost of provision of intensive care for patients aged 80 or older. Theilen(23) compared the cost from reduced intensive care admissions to the lower cost of simulation training for Medical Emergency Team and ward teams.

In the most detailed analysis Simmes(24) compared the cost of training, increased rates of vital sign monitoring and consults from a Medical Emergency Team with reduced cost from admissions to intensive care leading to a cost per patient day of €10.18 in 2014 based on a cut-off for patients with a severity of illness equivalent to an APACHE II score(25) of 14 or more.

Muñoz-Rojas(26) reviewed a proportion of cases seen by Rapid Response Teams in a Spanish tertiary hospital. Adverse events (AEs) were defined as patient deterioration resulting in an unplanned admission to intensive care. Outcome measures were ‘defined as

the number of AEs, cardiorespiratory arrests, and ICU- and in-hospital mortality'. The actual outcomes were compared to expected improvements from the literature including a 25% reduction in cardiac arrests and a 50% reduction in mortality. Using costings from the Spanish health service the study suggested 'a cost reduction of EUR 896,762.00 in the first year and EUR 1,588,579.00 from the second to the fifth year'.

Stone(27) and co-workers examined a Hospital Airways Response Team responding to a limited number of Rapid Response Scenarios in a tertiary US setting comparing the cost of running the team and bills for call-outs to insurers as their key metric. In this setting the authors concluded that 'what is billable and non-billable may not reflect either the need for or the cost of providing the service.'

None of the studies address long-term complications of adverse deterioration events.

Remote patient-monitoring: lessons learned during the Covid-19 pandemic

Many of the assumptions about the delivery of care have been challenged by the COVID-19 pandemic. To do justice to the changed context we have added considerations triggered by the pandemic.

Health technology was scaled at population level to screen and track patients in the community with possible COVID-19 infection. Acceptability of the technology was challenged by concerns about privacy (28).

Early in 2020 the Covid-19 pandemic rapidly overwhelmed hospital capacity across the globe, forcing caregivers and administrators to find alternative ways of treating both covid and non-covid patients remotely using telemedicine approaches.

Remote wireless patient monitoring has several attractive features for the observation of patients admitted to Covid 'cohort' wards. By giving near-continuous insight in critical vital signs such as pulse rate, respiratory rate and SpO2, it could – at least in theory – alert the care team earlier to rapid deterioration and allow for timely transfer to the Intensive Care Unit(29), and thus reduce the incidence of potentially avoidable death on the ward. It might also reduce the number of necessary nurse visits to the patient room, which was an important safety issue during the first months of the pandemic there were severe shortages

of personal protection equipment and vaccines were not yet available. A study from the Netherlands, however, could not confirm a lower rate of nurse entries when continuous monitoring was made available to patients admitted to hospital with suspicion of Covid-19(30).

To relieve pressure on hospital beds, several initiatives tried to reduce the length of stay for patients with Covid-19 requiring hospital admission, either by allowing more comprehensive home monitoring and treatment in an effort to avoid or delay hospitalizations(31), or by offering recovering patients earlier discharge from hospital with home monitoring of vital signs, home administration of low flow supplemental oxygen (if needed) and daily tele-contact with the care team. A small randomized trial by van Goor et al(32) confirmed that remote hospital care for recovering COVID-19 patients is feasible, but the authors were unable to demonstrate an increase in hospital-free days in the 30 days following randomisation. Similar initiatives were started around the same time in several countries, but most of these programs had no control groups and reported (positive) results only in the media rather than in peer-reviewed journals.

Detecting deterioration in patients with chronic disease during lockdowns is challenging. Many centres adapted their chronic disease management to the restricted hospital capacity and intermittent lockdowns by increasing the availability of telemedicine solutions. For example, patients in Italy were provided with one or more monitoring devices and a smartphone app that could collect patient responses and transmit data recorded by the monitor to the care givers (33).

While the landscape of proactive care to prevent deterioration has changed these like the studies above did not formally evaluate health economic impact of the interventions.

Insights from the expert round table

General considerations in relation to health economic principles

Health economics is the discipline concerned with optimal allocation of resources to maximize population health from the best possible configuration, delivery and use of

healthcare. Given that resources for healthcare are finite, economic evaluations are a method used to estimate the opportunity cost associated with any investment decision, that is, the marginal benefits forgone as a result of displacing existing treatments or services to fund new healthcare interventions or services. Net health improvements result if the marginal benefits gained exceed the marginal benefits forgone. The notion of opportunity cost is central to the activities of Health Technology Assessment organisations, such as the National Institute for Health and Care Excellence (NICE) in the United Kingdom, which considers evidence on clinical effectiveness and cost effectiveness to inform decisions on whether healthcare interventions represent good value for money for the National Health Service. An important consideration in this context is that of allocative efficiency, which occurs where the ratio of marginal benefits to marginal costs is equal across all health care programmes in the health system. Benefits are typically expressed in quality-adjusted life years(34), which are a generic, multi-attribute measure of health outcome encompassing both health-related quality of life, weighted by societal preferences, and life expectancy. In the UK costs are typically those borne by the National Health Service (NHS), and include all direct medical costs that are associated with a service or intervention, including down-stream costs.

Value is for economists, usually an empirical claim about the extent to which certain states or things are observed (or believed) to be preferred over others. This notion of value plays an important role in HTA, primarily as a source of empirical evidence about a technology /intervention /service's anticipated effects.

Value based healthcare describes a set of metrics aligned to outcome measures, including patient reported outcome measures(17). Value based healthcare is aligned with priorities for the NHS in the UK(35,36). Value-based health taps into the therapeutic relationship and what really matters to individuals. This is relevant in the context of 'appropriate rescue' for those patients who may choose supportive care at home, for example, as they reach end of life.

In the context of at-risk and deteriorating patients, cost can be described as having direct and indirect aspects, with direct costs sub-divided into medical and non-medical costs, the latter further described in terms of fixed, semifixed and variable costs. Examples for the context of deteriorating patients are shown in table 1.

Application of principles to interventions that reduce the risk of 'failure to rescue'

We agreed the following approaches to defining the contexts and perspectives of health economic evaluations of management of deteriorating patients in community and hospital settings:

1. **Population**: While the terminology of acute deterioration is usually applied to patients that deteriorate in hospital, the potential value of any intervention has to be seen within the broader framework of the patient's whole pathway. It is possible to describe (and cost) interventions to prevent cardiopulmonary arrest in a hospitalised patient and to achieve timely admission to intensive care. However, the recovery and subsequent changes to quality of life after discharge home and the impacts on close family and friends need to be considered explicitly. Economic analyses can incorporate these and NICE, for instance, specifies that evaluations should include direct health effects for carers, where relevant(37). This is important given the significant impact of the inclusion of carer effects on cost-effectiveness(38), but can also be challenging as these effects may be harder to quantify.
2. **Value of interventions:** The value of interventions in response to deterioration ought to consider their opportunity costs and have a focus which is patient orientated. Mitigation of harm in a patient with an acute allergic reaction might involve mechanical ventilation, while prevention of harm in a patient at the end of their life might involve avoidance of mechanical ventilation. Both approaches may be cost-effective, but the evaluative framework (health outcome objective) will invariably differ.
3. **Pathways:** The cost-effectiveness of an intervention can only be determined in the context of patients' pathways. Taking as an example, the case of a 38-year-old patient who develops pneumonia requiring invasive ventilation following cholecystectomy: Value here will be very different from the case of an 89-year-old patient with dementia and swallowing difficulties who also develops a pneumonia. It will also be different for a 44-year-old patient receiving chemotherapy for lymphoma. It might be challenging to determine cost-effectiveness for highly heterogenous populations. For circumscribed high-volume pathways such as elective surgery, patients with advanced chronic illness,

or patients undergoing treatment for cancer with curative intent, etc cost-effectiveness is usually explained by factors such as baseline risk, treatment efficacy, costs, and patient preference(39). By being able to better describe subgroups in a heterogenous populations with these parameters the attributable health benefit of an intervention to a subgroup can be better defined(40).

4. **Cost perspectives:** Questions about costs are always applied to a specific constituency; but **cost to whom** needs to be considered: Standard health-provider perspectives consider direct medical and social care costs (e.g. NHS and Personal Social Services in the UK). A broader, societal perspective considers all relevant costs, whoever pays for them. This includes non-healthcare costs, such as productivity losses, informal care, and out-of-pocket expenses. The rationale for considering costs from a societal perspective may be justified in certain circumstance – such as in relation to decisions that concern maximising the welfare gains to society (or minimising the losses)(19). Accordingly, the costs to an individual patient, a healthcare organisation or wider society will vary for the same case-scenario e.g. the costs of patient care at home, after suffering a hypoxic brain injury following "successful" cardiopulmonary resuscitation, would be very different from a hospital, social care or societal perspective.

<u>Decision-making perspectives</u>

Individual perspective

Cost perspectives and the scope for including spill-over health effects that extend beyond individual patients (e.g. on carers, family, friends and other members of society) is typically determined by the decision-making authority. For patients, relevant perspectives include out-of-pocket, intangible and indirect costs (such as productivity losses), and health and wellbeing impacts on their intimate social group. Accordingly, the cost-benefit calculation for an individual (e.g. in the purchase of private healthcare) will depend on their individual risk, preferences and willingness to pay. In line with the insights on heterogeneity of populations individual perspectives will widely wary, and hence prices will be set on the basis of a free market economy.

Payer perspective

Organisational efficiency can only be understood within the financial context of a given system. Activity based systems will derive benefit from procedures that cause cost in other systems if the whole pathway is examined. For example, a Rapid Response System might reduce unplanned admissions to Intensive Care resulting in lost income for an organisation but this increase in organisational cost could be offset by significant societal benefit if a joined-up approach is taken. Within a publicly-funded healthcare system, and acknowledging the imperfect market for health, efficiency is typically based on maximising outcomes – such as the quality-adjusted life year (QALY) within constrained resources based on the perspective discussed above.

Societal perspective

Failures to manage risk appropriately and the resulting harms create costs well beyond the immediate healthcare provider(41): staff involved in catastrophic events in the community or hospital may become 'second victims'(42) and suffer prolonged absence from work, may become overly defensive after return to work, or take early retirement. The cost of such cases has been estimated to be as high as £300.000 per adverse event. Furthermore, the bulk of the cost of a patient pathway is often outside the traditionally assessed frame of a 'hospital episode': that is, failure to rescue in hospital leads to greater expenditure on care at home and burden to families and communities.

Demographic context

While failure to rescue was originally defined in the context of reversible complications after surgery, demographic changes mean that many patients identified as deteriorating in the hospital or at home are in the later stages of life suffering from conditions with limited reversibility. For example, complex surgical care was previously reserved for relatively young and healthy patients, but today complex surgical and oncological care is open to octogenarians with multiple comorbidities. Value might often be added by a 'what matters conversation'(43) with patients and those close to them to identify the value of interventions within the framework of personal ideals and beliefs of the patient. This approach has the potential to avoid over-treatment, de-escalate care that does not give benefit, and de-medicalise the dying process. It may contrast with the notion of maximising QALYs; although NICE accepts alternative health-related quality-of-life measures where the preferred EQ-5D(44) is not appropriate.

Patient case study

The metrics described above and summarized in Table 1 were applied to a scripted case study based on case studies used for the Nightingale Program (18). This fictitious patient was used to illustrate the above principles across a whole patient journey: A 54-year-old woman with a past medical history of hypertension and diet-controlled diabetes, and a good performance status of 1 undergoes a resection of her colon which is complicated by an episode of intra-abdominal sepsis. Depending on appropriate monitoring and escalation two variations of the scenario might unfold leading to differential costs for the patient, the team looking after her and the organisation (Figure 1).

On examination of the case-study we identified a number of relevant challenges for the economic analysis of Rapid Response Systems as a hospital-based intervention: The cost of providing a team, monitoring and training have to be balanced against a broad range of benefits, many of which are beyond the patient affected by a potential catastrophic event and difficult to capture from routinely available data. By mapping categories of cost against the case-studies we were able to illustrate the scaffolding of a financial metric in this area.

Table 1: Cost categories as applied to the deteriorating patient

Cost	Direct medical cost	Direct non-medical cost	Indirect cost	Intangible cost
Fixed	• Facilities (hospitals, training /simulation centre) • Rent, utilities • Monitoring equipment • Training in recognition and response to the deteriorating patient (staff replacement costs)		• Litigation • Indemnity • Compensation settlements	
Semifixed	• Nursing staff • Medical staff • Rapid Response Team			
Variable	• Cost of additional tests after a deterioration episode	• Cost to family for support at home or in hospital • Cost to social services after acute illness	• Loss of income to patient and employer • Loss of time for care of other patients	• Anxiety, pain or suffering

	• Costs of unplanned returns to the operating theatre / ICU admissions and readmissions, increased lengths of stay, further treatments • Savings from prevented ICU admissions, decreased lengths of stay etc	• Loss of productivity of hospital staff following adverse events • Loss to hospital reputation	• Early retirement after acute illness • Reduced productivity • Loss of income to hospital for missed other activities	

DISCUSSION

What we have shown

To our knowledge, this is the first time that health economic methodology has been discussed in the context of this specific aspect of patient safety. In accordance with standard methods of health economics we explored the overt and hidden costs and benefits of such systems. We argue that meaningful evaluation of interventions aimed at reducing 'failure to rescue' needs to include whole patient pathways beyond the narrow focus of 'hospital episodes'. and provided guidance for decision-makers at the level of integrated healthcare structures as well as individual community organisations or hospitals.

What others have shown

Health economic methodologies are commonly used in assessing medication safety (45–48) and the cost-effectiveness of interventions(49–51). While electronic health records have been hailed for their potential of high safety impact(8) the evidence for impact beyond medication safety is currently missing(52). Health economic considerations for other aspects of patient safety are surprisingly limited(53,54). Round tables a commonly applied method to achieve insights relevant for healthcare policy (14,15,55).

Value is best realised along the whole patient journey and outcomes need to matter to patients(56). The application of business thinking to safety has been criticised because of market failure(57) but we believe that in a time of considerable pressure on resources it is necessary to review all aspects of patient management through the lens of value-based healthcare.

Health economic impact of safety interventions might be relevant for commercial viability through 'brand image'(58) but result in lower earnings from treatment of complications(59).

Berwick and co-workers argue that the 'business case for quality' and subsequently safety depends on whether 'improvement [is] considered a part of the core of health care or an optional feature', who will financially benefit from safety interventions and whether nonfinancial consequences matter(60).

Time-driven activity-based costing is a commonly used method to estimate value: it uses the cost of capacity-supplying resources divided by the capacity of those resources and the time

required to perform activities(61): for resources that are ‘on stand-bye’ such as resuscitation or rapid response teams this might not be a suitable model(62).

The explosion of mHealth applications during care of potentially unwell patients during the COVID-19 pandemic has distinct implications for patient safety(63,64) and the generation of value: applications are imminently scalable but efficiency(65) and safety implications(66) are often not tested sufficiently prior to implementation. Patients’ perception of usefulness and promotion of health will influence update and impact(67).

Strengths and weaknesses

The present publication used the abbreviated format of the Rapid Review of the literature. Given the scarcity of the publications identified the authors believe that a systematic review would have been unlikely to identify literature that would have substantially altered the learning.

The authors did not have access to empirical data of care of patients who suffered deterioration events. Despite this the roundtable, conducted with leading experts in the field, identified important and novel findings, namely the importance of long-term complications of patients, relatives and staff for the costing of safety interventions.

Failure to rescue is a complex phenomenon and this manuscript can only capture a small selection of the potential challenges of applying the methodology of health economics to this aspect of clinical care. The economics of futility of interventions at the end of life is a difficult issue (68,69), in many areas robust data is missing which currently precludes completely definitive answers to questions about whether or not the various strategies to improve timely recognition and response to deterioration are cost-effective in the same way that other technologies might be appraised within the context of quality adjusted life years.

Clinical implications

In order to successfully embed rapid response systems into community and hospital care adequate resources must be allocated to each component of such a system: staffing (numbers, skill-mix), education (patients, informal carers, nurses, doctors, therapists), and technology.

Beyond the costs of harm to patients and staff it is becoming increasingly clear that adverse events and patient harm can lead to significant reputational damage to organisations and subsequent difficulties in recruiting and retaining staff i.e., the increase in locum costs is not usually related to organisational safety but might provide major financial challenges to healthcare providers with poor public ratings. Many costs (and indeed outcomes) are hidden along with key impact and interdependencies along the pathway. Pathways of a patient needs to be hence evaluated in their entirety.

Implications for research

In this manuscript we have illustrated how principles of health economic methodology can be applied to a specific topic of risk and harm in patients suffering catastrophic deterioration through acute illness or worsening chronic illness. From our observations a number of dilemmas emerge that require further dedicated research:

- Value to patients can be defined within the framework given by the international consortium for health outcome measurements(17) as used with reference to patients with pre-existing conditions or within a framework that will maximise value for the health service. In order to quantify value for patients, patient experience and outcome measures are required but for patients with acute syndromes such as sepsis, or delirium, few patient-reported outcome measures exist.
- From our observations pre-emptive 'What matters conversations' can be beneficial to patients with chronic disease who often do not appreciate the many deleterious complications of intensive treatments. These might help to determine better informed preferred pathways in cases of likely future deterioration. Research is needed to identify the optimal timing and format of such conversations and their feasibility and impact in complex clinical environments.
- Early recognition of deterioration by, for example, wearable vital sign monitors or by healthcare staff or families close to patients is likely to aid timely treatment. Whether this type of strategy is cost-effective for organisations and adds value to patients will depend on the sensitivity and specificity of the systems used; currently used methods might lead to many false positive alarms and increased marginal costs that outweigh likely savings down-stream.

CONCLUSIONS

While Rapid Response Systems are being used in many countries as a patient safety strategy to reduce 'failure to rescue', we have found only a limited number of studies that have examined health economic aspects of the intervention. From our review of the literature and understanding of international practice value might arise from several domains:

For health care organisations value might be foremost found by examining long-term outcomes of survivors of cardiac arrests or critical illness and by analysing staff sickness rates related to the experience of catastrophic adverse events and

For policy makers, depending on the jurisdiction, value might be quantifiable by examining the cost of litigation in relation to events of failure to rescue.

More detailed work is required to allow policymakers and executive teams to fully understand the value of the investment compared to other health care interventions.

Contributorship Statement

CPS organised the round table. CK, CPS, JW, RS undertook the rapid review of the literature with CS and RS undertaking the first screening of the references.

CPS, DH, SL, EH, CK, RS, ST, JW took part in the round table event and contributed independently to the manuscript. All authors reviewed and approved the manuscript.

The artwork was commissioned for the manuscript by CPS from Hannah Thorpe.

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Ethics approval

The study does not involve human participants. It is a literature review, an expert round table and a fictitious case study. It did therefore not require approval by an ethics committee.

Caption

Figure 1: Case study of a hypothetical patient with two scenarios: Scenario 1 with optimised care supported by a Rapid Response Team (RRT), Scenario 2 with failure to rescue. The bottom row of the figure shows items with potential loss of value.

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Competing interest statement

SL is Welsh lead for Value Based Healthcare. JW is previous president of the International Society for Rapid Response Systems. There are no other conflicts of interest.

Data sharing statement

All data relevant to the study are included in the article or uploaded as supplementary information.

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