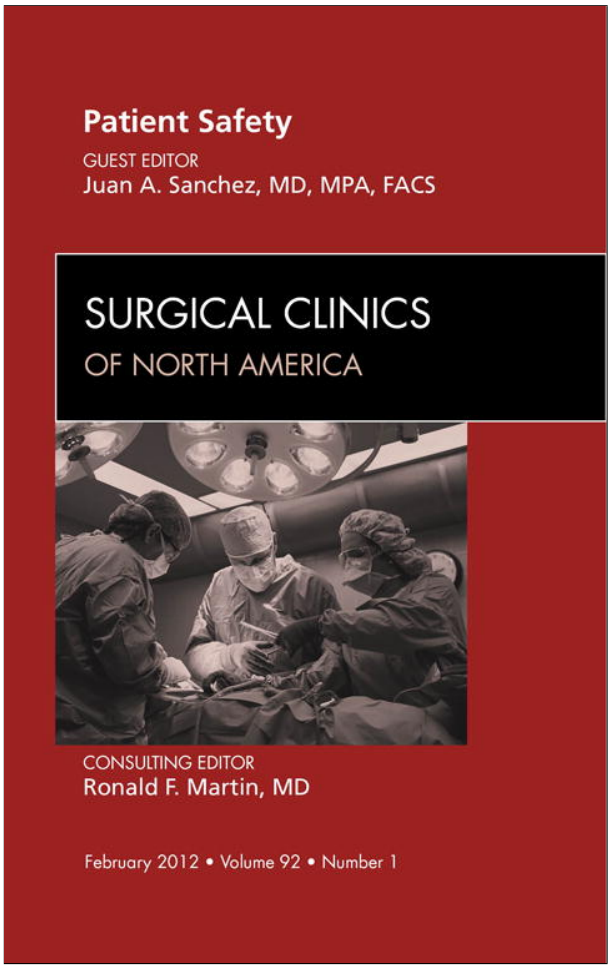

Making Sense of Root Cause Analysis Investigations of Surgery-Related Adverse Events

Bryce R. Cassin, RN, AFCHSM[a,b,*], Paul R. Barach, MD, MPH[c,d]

KEYWORDS

• Root cause analysis • Patient safety • Adverse events
• Sense making • Structured conversation

May it not be that our naïve intuitions are not so far wrong after all and that causal laws in relation to persons are few because persons are not entirely subject to them.[1]

WHAT HAS BEEN LEARNED FROM ROOT CAUSE ANALYSIS ABOUT SURGERY-RELATED ADVERSE EVENTS?

The conversation related to patient safety has gained currency in the last decade and incident investigation processes have been implemented by health care organizations internationally to improve the safety of clinical care delivery.[2] The most common method used as a primary means of investigating serious adverse events is root cause analysis (RCA).[3] The Institute of Medicine's (IOM) report, *To Err is Human*, stated that "root causes are complicated by the fact that several interlocking factors often contribute to an error or series of errors that in turn result in an adverse event."[4] Two significant facts emerge from this quotation: the IOM investigators view error as causally linked to medical management (or rather, bad systems) and that the complication they describe is one of collecting administrative data for the purpose of raising awareness of the issues, not taking specific action to better understand

[a] University of Western Sydney, School of Nursing and Midwifery, Locked Bag 1797, Penrith South DC, New South Wales 1797, Australia
[b] University of Technology, School of the Built Environment, PO Box 123 Broadway, Sydney, New South Wales 2007, Australia
[c] Utrecht Medical Centre, University of Utrecht, PO Box 85500, GA 3508 Utrecht, Netherlands
[d] University of Stavanger, 4036 Norway
* Corresponding author. University of Western Sydney, School of Nursing and Midwifery, Locked Bag 1797, Penrith South DC, New South Wales 1797, Australia.
E-mail address: bryce.cassin@gmail.com

Surg Clin N Am 92 (2012) 101–115
doi:10.1016/j.suc.2011.12.008 **surgical.theclinics.com**
0039-6109/12/$ – see front matter

the clinical workplace.[2] The IOM report was primarily concerned with presenting hard numbers to draw public attention to patient safety.[2] The chosen vehicle at the time was error counting and reporting systems. Making sense of the situations behind the interlocking factors and bad systems is now more important than a statistical count of errors, a retrospective search for causes, or high-level planning documents about top-down system redesign.[5] Key advocates in the patient safety movement acknowledge that current systems are too complex to expect people to perform perfectly all of the time and that leaders have to put in place systems that support safe practice.[2]

There is an urgent need to build ground-up capacity to make sense of the complexity in care systems having raised awareness about improving patient safety. The next stages in the patient safety movement's plan must involve practical experimentation with meaningful tools and methods at the local level where clinical teams can own and control improvement not as a time-limited administrative project, but as a natural part of the ongoing shaping of habits and routines in care delivery. For example, to better understand the clinical context of complex care, significant investment is being made in surgical simulation and skills development.[6] After more than a decade of significant investment in improvement activities such as RCA, it is timely that due consideration is given to assessing the quality of information available and how it is interpreted, because many myths prevail.

Has progress been made in better understanding the interlocking factors in the clinical work environment by collecting data? There is a pervasive belief among advocates of the patient safety movement that all errors in a health system are discoverable and preventable. Senior industry leaders involved in the 1999 IOM Report have pushed toward achieving zero incidence of errors, and more and better data[2]; it is not an isolated view.[7,8] The belief is primarily that having more information is sufficient to improve health systems. However, there is no palpable sense in administrative data of the reality of delivering care in unpredictable situations. The more sensitive analyses based on expertise in accident investigation acknowledge that "adverse events should be characterized as emergent properties of complex systems; they cannot be predicted."[9] Perhaps the explanatory hypotheses for getting, doing, and talking about bad systems need revision to make better observations of clinical care.[1] Many errors are preventable and, through the RCA process, system flaws are identified, recommendations are made, and sometimes solutions are implemented, only to see the problem recur. Simple equipment failures can be addressed via high-level system responses that replace or fix the broken part, but many RCAs relate to complex social, emerging interaction issues that require action at multiple levels of the system, from the local clinical unit, to teams, departments, and whole facilities. If RCA is only suited to a high-level analysis of specific, prevalent problems,[10] why is it still extensively used across health systems to investigate all types of serious adverse events?

This article draws on the experience of facilitating more than 100 RCA investigations across one Australian health delivery service in New South Wales. Several themes emerged from reviewing these RCAs that are relevant in understanding the surgical context. These themes (**Table 1**) represent a mixture of the outcomes of clinical care (eg, procedural complications) and explanations relating to problems in the clinical environment (eg, skill mix of the surgical team, and missed diagnoses). The purpose in reviewing the surgery-related RCAs here is not to attempt a comprehensive classification system but to highlight the patterns that emerge from the RCA reports that may assist clinical leaders in determining priorities in relation to improvement activities. The number of themes and issues carries no predictive value, nor are they characterized as causal to the outcomes of the events. Their significance is in their descriptive value of RCAs and as design challenges relative to particular situations in the clinical workplace.

Table 1
Themes and issues identified from surgery-related RCAs

Theme	Issues Identified
Failure to recognize or respond appropriately to the deteriorating patient within the required timeframe	Post-CABG complications Postoperative sepsis Postoperative hyponatremia
Workforce availability and skills	Orientation, training, and supervision of new or junior members of the surgical team, especially outside normal working hours
Transfer of patients for surgery	Difficulty in organizing an OR for surgery Failure to hand over information about patient acuity
The management of trauma	Coordination and response of trauma teams Clinical decision-making process for patients with trauma Coordination of care between multiple clinicians
Access to emergency OR	Antepartum hemorrhage and emergency cesarean Urgent orthopedic procedure Urologic complications requiring urgent surgery
Missed diagnosis	Thoracolumbar fracture in a patient with trauma Brain abscess mistaken for cerebral metastasis Subarachnoid hemorrhage thought to be drug overdose
Unexpected procedural complications	Airway obstruction after thyroidectomy Failed intubation
Sentinel events	Wrong site procedure: spinal fusion at wrong level Retained surgical products requiring surgical removal

Abbreviation: OR, operating room.

Data from The analysis is derived from a metropolitan health service, Sydney, NSW, Australia. Personal communication, Deputy Director for Clinical Governance, January 2007.

A visual survey of **Table 1** shows that it is difficult to draw generalizations from RCA data because the issues are multifactorial and require a systemic response. The data are presented as they were reported to show that making sense of the themes and issues requires further information about the RCAs. We draw attention to the importance of assessing RCA data in context to gain a meaningful understanding of the clinical workplace. Our RCA data may or may not inform the clinical risk management processes in other surgical centers. The themes mentioned are likely to be familiar, but so too is the experience of frustration with the quality of detailed information emerging from the RCA reports. Citing these themes and issues arising from RCA reports illustrates the complex nature of the problems involved. The formal RCA process seeks out clearly identified problems, where facts can be analyzed, efficient solutions recommended and effectively implemented, and the system of care modified quickly and rationally. However, the problems cited are never simple or easy (see **Table 1**). These complex problem situations have been identified as so-called wicked problems that are characteristic because they resist easy formulation, cannot be easily isolated from the system of care, have no clear causal relationship, are not exhaustive descriptions of the problem, and can be explained in many ways.[11] Wicked

problems are related to other problems, have no simple fix, but require a specific response that only makes sense in the context of the unique characteristics attached to the problem described. What is missing from **Table 1** is the real-world settings of the problems, and how clinicians at the time of the events concerned made sense of the situation that confronted them, with its unpredictable and contingent characteristics.

WHAT HAS BEEN LEARNED FROM RCA?

A central hypothesis proposed by the article is that the environment of clinical practice and the thinking it entails resist reduction to stable and standardized risk identification. First, the historical context of the everyday experiences of clinicians is not captured by statistical measures used in evidence-based medicine. Second, the clinical experience is more dynamic than the simple cause-and-effect sequences constructed in RCA flow charts and investigations. This problematic situation warrants open and frank discussion to identify a more effective model of inquiry.

A key observation that emerged from the experience of facilitating multiple RCAs is that the methodology has a limited usefulness beyond sequencing facts and listing problems.[12] There is a tendency among clinicians to focus thinking around familiar evidence-based clinical models in which statistical variation in clinical medicine can be measured and the probability of its significance quantified.[13] However, understanding the dynamic interaction and communication problems that arise from the social complexity of clinical work, the most common issues identified by RCA, is not a subset of clinical medicine. Developing an understanding of unexpected events in the clinical setting requires a different set of tools and mental model. The clinical workplace is not a controlled experimental environment and its risks are ambiguous, constantly emerging, and unpredictable. Risks in clinical care delivery are situational and context specific. The clinical workplace needs to be understood in its temporal context, where managing constraints and negotiating the boundaries of safe practice is a matter of collective expertise and experience. This context requires reflection on clinical judgment and decision making. When RCA teams are faced with the complexity of a past event, there is no experimental control, nor any assurance that their recommended actions will reduce the risk of recurrence of the event in the future.

Public and political interest in the outcomes of RCA has shifted the focus of attention from the context-specific nature of the situations investigated by RCA to the collection of abstract categories of information that satisfy the need for generalized administrative data. The continuous flow of activity in the clinical workplace cannot be reduced to simple data mining and dredging. What is significant in one event, with its unique set of circumstances and mix of clinical expertise and environmental factors, is unlikely to be true or applicable to another event simply because it is given a similar label in administrative data sets.

Surgery-related adverse events rarely present as discrete causal sequences within the clinical setting. RCA teams respond pragmatically in team meetings by reflecting on broader issues in the clinical workplace drawing on their own experience and observations, which raises questions about the limitations of RCA as a key method of analysis and the compensatory role of the expertise of RCA teams, including:

1. Why have RCAs failed to significantly improve the capability (ie, safety, quality, reliability) of care delivery systems?
2. How do RCA teams compensate for the limitations of the RCA methodology?
3. What can be learned from accident analysis models about the alternatives to RCA?

MEASURING SAFETY: THE ACCIDENT PARADOX

Many organizations use RCA-driven adverse event data as an index of the relative safety of their constituent parts or subsystems. Adverse events, like the number of errors, are poor indicators of the general safety of the system.[14] Only if the system has complete control over the factors causing adverse events and near misses could an adverse event history provide a reliable measure of its safety. Hazards can be moderated but they cannot be eliminated, which may lead to the accident paradox in which safe organizations can still have bad adverse events, whereas unsafe systems can escape them for long periods. Furthermore, progress creates new risk that is difficult to anticipate but is a feature of new procedures and technologies.[15]

One way to resolve this paradox is to recognize that safety has two aspects. The positive aspect of safety (ie, intrinsic resistance to chance combinations of hazards, unsafe acts, technical failures), like good health, is difficult to define and even harder to measure. By comparison, the absence of safety, like poor health, is clearly signaled by near misses, injuries, and fatalities, which lend themselves to close analysis and quantification. However, the data provided by RCA accident and incident reporting systems, although essential for understanding the causes of past mishaps, are both too little and too late to support measures directed at enhancing a system's intrinsic safety.[16]

Many organizations treat safety management like a negative production process. They assess their negative RCA outcome data and then set themselves reduced targets for the coming accounting period. The trouble with this approach is that errors and adverse events are not directly manageable. A more effective model for safety management is to monitor the system's process or vital signs on a regular basis (ie, indices relating to quality management, equipment design, workplace design, conditions of work, safety procedures, communications, maintenance, and so on) like a long-term fitness program. The program is designed to help clinicians and managers bring about continuous, step-by-step improvement in the system's intrinsic resistance to chance combinations of latent failures, human fallibility, and hazards. This program entails managing the manageable: that is, the organizational human factors that lie within the direct spheres of influence of clinicians as they go about their daily work.[17]

In contrast with a systematic approach to continuous improvement,[18] the introduction of mandated RCA investigations for serious adverse events requires clinicians and managers to isolate elements in the workplace systems for attention without reference to the other parts of the system. Health service managers and policy makers invest considerable resources and commitment in RCA educational programs because they assure a degree of control and certitude in managing the clinical environment. RCA promises greater control over clinical practice through the identification of corrective actions, but with no clear process for implementation of, nor accountability over, the recommended changes. Tangible benefits to the clinical setting are needed to achieve clinician buy-in. Strong murmurs of discontent and cynicism were initially observed (for medical staff, RCAs were only a small part of a bigger problem to do with a general lack of an overarching view of the system).[19] RCA meetings also created an opportunity for improved communication in the workplace through organized sense making, which was otherwise ad hoc. This opportunity entailed a process whereby different approaches to noticing and bracketing clinical care are shared across the boundaries of specialism, expertise, and different clinical disciplines.[20]

HAVE RCAs ALTERED THE IMPROVEMENT CAPABILITY OF SURGICAL CENTERS?

The emphasis in RCAs on causation and error management is not an effective method to engage clinicians nor to improve understanding of the clinical workplace. Perhaps

the wrong questions have been asked about adverse events by focusing on categorizing error and crafting causation statements rather than asking how clinicians maintain their continuity of practice amidst the changing and dynamic conditions that characterize the clinical work environment.

The RCA process has recently been defined as an essential tool of vigorous system investigation, assessment, learning, and improvement, with an emphasis on respectful engagement of frontline clinical staff, patients, and families in the process.[21] This shift is an important step forward by recognizing the important role of the *conversation space* in RCA investigations. Previously, the focus in RCA programs has been on the stepwise process of causal reasoning.[3] Changing the focus to capture the agency of the people involved will enable institutional assumptions in the RCA process to be questioned around:

1. Do disruptions to clinical practice ever happen in sequence?
2. Are problems, once fixed, less likely to recur?
3. Are root causes quantifiable for particular events as categorized in reports?

These goals have more to do with the mission of government and large agencies around comparable performance measurement than improving health care outcomes. RCA reports omit the significant detail that surgical microsystems need to know to improve the safety of their local practice. The context relates to specific times, and places for patients, clinicians, and managers interacting around care delivery in constantly changing and often uncertain circumstances. Government policy assumes that information gathered from RCA reports will translate into corrective actions but without an identifiable process for implementing practical change nor due regard for the differences between local clinical contexts. Lee Clarke,[22] an organizational sociologist, describes concentrated managerial initiatives like RCA as a rational process to tame risk and uncertainty, opining that:

> *When organizations analyze problems, they try to transform uncertainties into risks, rationalizing problems previously outside the realm of systematic control… The organizational urge behind these transformations is part of the characteristic drive for rationalization in modern society… this urge reflects a societal-level expectation that organizations should be able to control the uncertain, and be able to respond effectively to the untoward.*[22]

The belief that there are causes to be discovered in the organization is socially constructed from the benefit of hindsight after an event.[23] We observed that working with people in the visceral setting of the RCA team meeting was a more meaningful way of capturing the collective mindset as people discussed how flexible and adaptable strategies were routinely used, including workarounds and variations from local policies. This normalized deviance in which workarounds and rule breaking were part of everyday work caused surprise at times to risk management personnel, but, for clinical personnel, was seen as part of getting the job done. Surgical microsystems require something more than rational planning when responding to unexpected events. There is a risk that RCA reports only hold symbolic value at a policy and senior management level. The proliferation of collated reports about RCA findings provides no traction for making sense of the local complexity in surgical work environments.

Public reporting on RCA outcomes dilutes the rich contextual information clinicians need to respond to problematic situations in the clinical workplace. The multiple layers of bureaucratization that prevent timely feedback on RCA findings have increasingly frustrated clinicians and led to delays in immediate attention to the system solutions that could be implemented. Monitoring RCA report outcomes has morphed over time

into a sustainable specialism within health departments. Multiple systems for gathering event data have been developed, reducing comparability, rendering the possibility of system level learning even less feasible. The statutory and professional requirements for mandatory reporting (eg, deaths in surgery, deaths under anesthesia, and medico-legal claims) have generated databases for these types of events and resulted in more predictable event reporting (eg, there is widespread focus on identification of the deteriorating patient, preventing wrong-sided surgery, improving clinical handover, and increasing hand washing among clinicians). As reporting systems multiply, it is imperative that effective structures are put in place at the hospital level where organizational factors associated with clinical adverse events are best understood.

Drilling down to the level of specific incident types and the practice of listing and categorizing events is not sensitive to the changing nature of serious risks in different contexts within and across health services. RCAs reveal considerable variation in the way adverse events are perceived by different clinicians and clinical teams. High-level descriptive analyses of RCAs may be able to highlight local patterns but rational-looking labels in collated reports of adverse events do not improve the ability of local clinicians to manage the constraints in their particular clinical environment. What fascinates RCA teams and occupies the local clinical review meetings is how problems emerge and how best to respond to messy situations and breakdowns in safety. RCA teams and local clinicians need to understand the connections between people at an individual, team, department, and interdepartment and cross-team level.[24] RCA teams are particularly good at looking at small pieces of problems and grasping the complexity that exists across their hospital or health service. The solutions that emerge from RCA team discussions respond to the specific embedded routines and habits of local clinical teams. Their concern is not with causes, but shedding light in a manner that makes sense to the people who will need to adapt their practices in response to the next unexpected event: "if such things can somehow be made visible, a fuller range of counter measure becomes available beyond telling frontline operators to be more careful."[25]

It is noteworthy that only a small number of sociotechnical events have identifiable causes, because most adverse events involve complex social and cultural problems.[26,27] Failure at a bureaucratic level to grasp the importance of local clinical perceptions and sense making limits the usefulness of RCA as a tool for improvement in health services. Although concrete actions recommended in RCA reports have been successfully implemented for stable technology and equipment-related issues (eg, bar code technology for medication administration, electronic medical record systems), it has been harder for large patient-safety agencies to grasp communication with frontline clinical staff as a source of organizational intelligence, beyond compliance with administrative reporting systems.[28]

Moving the discussion closer to the mindset of physicians and surgeons reveals another problem: a widespread assumption that understanding adverse events is a subset of logical clinical care. Senior clinicians contributing to RCA teams look for elements within events where means and ends can be identified and cause-and-effect thinking has rational application (such as the interpretation of a clinical event using case-based reasoning).[29] The combined impact of promoting causal reasoning in RCA investigations and defaulting to a search for clinical causes is to give the impression of an explanation of complex social and cultural problems in adverse events, when instead these issues require an approach to inquiry that can shed light on particular clinical environments.[30] This kind of thinking is more like the practical judgment and decision making surgeons apply in the operating room where patient circumstances are unpredictable and information is incomplete. A surgical team

assesses situations by surveying and evaluating the work environment, where they consciously identify what is new or different, not by looking for causes or stable qualities via some abstract notion of a health care system.[31]

At the heart of understanding an adverse event is a realization of the pragmatic thinking skills of clinical assessment that help create an awareness of situations. RCA team members apply the same attentional and perceptual skills to interpret an adverse event as they would an altered situation in the surgical intensive care unit, in the absence of any meaningful access to what made sense to their peers at the time of the past event under review. RCA teams function like clinicians in the workplace who manage real situations where expertise, workload, and expectations are highly variable factors.[31] However, the value of practical clinical reasoning is lost in the causal language of RCA talk. RCA documents make claims that strive to reduce uncertainty, whereas clinicians have learned to live with it and embrace its richness.

The specific causes of an event are not discoverable; there is no root or primary cause that can be identified as an end point because the workflow in an organization is continuous.[25,27] The RCA training material asks RCA teams to look for the sources of error in the system of care but does not equip RCA teams, beyond a rudimentary introduction to human factors concepts, with the detailed cognitive human factors training to make practical recommendations that address the system complexity.[32]

The simplified list of human factors categories in the US Veterans Administration (VA) National Center for Patient Safety (NCPS) RCA triage card (**Table 2**) can be likened to a 'constant accident model' (**Fig. 1**) in which the thinking about adverse events is not discreet, but oscillates between technical and equipment causes, issues in relation to human performance, and factors within the organization.[12] However, a search for attributes or causes obfuscates the social complexity of clinical work by creating an illusion of stable risk and safety characteristics in the system of care.[33]

An understanding of the continuously changing dynamics and unforeseeable complexity of clinical work does not emerge from the precise event sequence constructed by the RCA methodology. The search for root causes is an abstract notion and RCA teams devote lengthy discussions to defining the start and end points of an event.[12] The conversation is frustrated because a causal sequence derived from favorite categories establishes a symmetry that is hard to discern in the reality of messy clinical situations.

The experience of participating on an RCA team is like the moments of uncertainty in the operating room or hospital inpatient unit, where thinking needs to adapt to the situation at hand. Experienced clinicians are quick to see the limitations of causal reasoning in RCA, just as they learn that sorting causal sequences into a taxonomy of disease belongs to medical education more than clinical practice.[30] The practical reasoning of an experienced clinician is necessary on an RCA team where received knowledge is questioned, new possibilities must be considered, and experimentation with alternative ways of working explored: "this means that while physicians (and surgeons) may profess a simple, linear idea of cause and effect, they frequently work as if cause were complex and multifaceted."[30]

The challenge for a hospital executive or policy maker reading an RCA report is that there is no readily available process for controlling future events or predicting how clinicians might respond to uncertain situations. The aggregated reporting of RCA outcomes has more to do with the desire for predictability in processes of health care management than clinical practice. Surgical teams regularly work around the operational limitations of rational organizational plans to safely deliver care. Problems in clinical practice emerge out of complex conditions that could not be predicted in advance.[12] Clinical explanations of adverse events focus on situational responses

Table 2
The VA NCPS RCA triage card of questions

Concepts Used to Identify Contributing Factors	Scope of Questions
Human factors: communication	Flow of information Availability of information Organization's culture of sharing information
Human factors: training	Routine and special job training Continuing education Timing of training Interface between people, workspace, and equipment
Human factors: fatigue/scheduling	Resulting from change, scheduling and staffing issues, sleep deprivation, or environmental distractions Management concern and involvement
Environment/equipment	Use and location of equipment Fire protection and disaster drills Codes, specifications, and regulations Suitability of the environment Possibility of recover after an error
Rules/policies/procedures	Existence and accessibility of directives Technical information to assess risk Feedback mechanisms Interventions developed after previous events Incentives for compliance Qualifications match the level of care provided
Barriers	Protection of people and property from adverse events Barrier strength, fault tolerance, function, and interaction/relationship to rules/policies/procedures and environment/equipment

Available at: http://www.patientsafety.gov/CogAids/Triage/index.html#page=page-1. Accessed December 18, 2011.

rather than stable risk management plans. RCA teams often find it hard to fit their explanations into the language of an RCA report because they know that an "exact failure, in precisely that sequence, will be very unlikely to recur."[33] However, the RCA process tends to focus on the fixable properties of local subsystems and the recommendations are intended to correct the specific issues in the particular adverse event.[34] Successful RCAs look beyond the immediate event and develop recommendations that equip clinicians to respond to similar circumstances and adapt to the unexpected in the clinical workplace.

RESPONDING TO THE LIMITATIONS OF RCA

The RCA process has raised awareness of the need to better manage and respond to adverse events in clinical settings. Many significant problems identified by RCA teams in the last decade have resulted in concerted efforts to better equip clinicians to

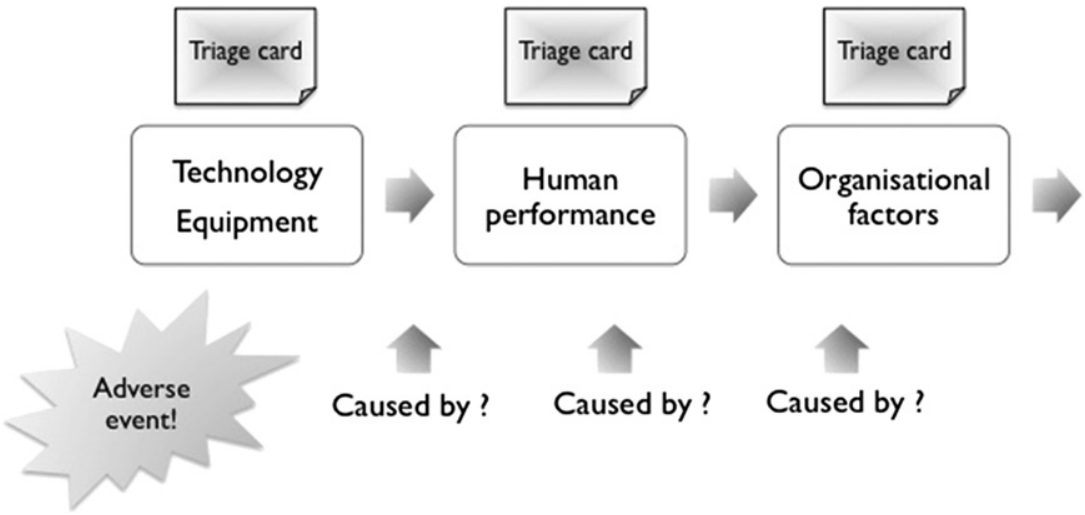

Fig. 1. The constant accident model. The search for causes via triage cards defaults to favorite categories of error. (*Adapted from* Hollnagel E. Thinking about accidents. In: Barriers and accident prevention. Aldershot (United Kingdom): Ashgate; 2004. p. 36–67.)

respond to different categories of safety threats (eg, identification of the deteriorating patient, surgical team briefing, and standardized clinical handover).[35] However, the response to the RCA recommendations is universally uninspiring and many suggestions from RCA teams remain unimplemented.[36,37] RCA is unsuited to capturing the dynamic conditions of the clinical workplace and contrasting perspectives on error and event analysis reinforce this view. It is important to acknowledge that RCA is an incident investigation model with substantial limitations when applied to health care, and to consider alternative tools for the management of serious clinical adverse events. For example, analyzing an event across all levels of an organization by using The London Protocol,[38] or building an understanding of organizational risks through sense making by applying tools that stimulate conversations about processes (eg, failure modes effect analysis) or conversations about system level concerns (eg, probabilistic risk assessment).[39,40]

The different types of accident analysis models (**Table 3**) help to situate the challenges of using RCA to investigate clinical adverse events.[12] The choice of accident model directly influences claims made about the space an event occupies in terms of past experiences, current intentions and relationships, and ongoing constraints on the relations and action in the clinical environment.[41] Integral to the selection of an accident model is appreciating the nature of the event, the complexity of the workplace, the information available for analysis, and the appropriate response given the attributes of the system in place.

A sequential accident model (eg, RCA) is suited to the investigation of events in which there are specific causes and well-defined links and there is a high possibility of eliminating or containing causes.[12] An epidemiologic model looks at an accident in the same way that a clinician describes a disease. The principle behind the inquiry is to discover the factors that combine (ie, performance deviations, environmental conditions, protective barriers, and dormant conditions present in the system before the event).[12] The systemic accident model contrasts the first 2 approaches in that it looks at phenomena that emerge in the normal flow of clinical activity. The systemic model looks for linkages between different interactions that affect performance and constrains the type and level of response to changes in relations in care delivery[12]:

> *The overriding advantage of systemic models is their emphasis in that accidents analysis must be based on an understanding of the functional characteristics of*

Table 3
The assumptions behind different accident models

Accident Model	Objective	Assumption	Response
Sequential model Metaphor: Path	Eliminate or control causes	Cause and effect relationships exist in the adverse event	Search for root causes and contributing factors
Epidemiologic model Metaphor: Net	Identify deviations and implement defenses and barriers	Cause and effect relationships are latent within an organization	Search for the broken components within a broken system
Systemic model Metaphor: Forecast	Monitor and control performance variability	Complex conditions within an organization are emergent and variable	Build foresight to make sense of how system variations function within normal work

Data from Refs.[9,12,23,25,27,33,34]

the system, rather than on assumptions or hypotheses about internal mechanisms as provided by standard representations.[12]

In contrast with the systemic model, which is mostly suited to investigating clinical adverse events, the notion that a sequential accident model like an RCA can be effectively used to find ways to eliminate errors and injuries to patients is limiting.[8] In deference to many investigators in both cognitive psychology and human factors engineering, advocates of RCA in the patient safety movement consider that perfection is the benchmark and competency a central problem in advancing patient safety.[8] This is based on a belief that many doctors have deficiencies that need to be identified and corrected such as deliberate deviation from a known safe practice.[8] Making hospital care safer for patients and ensuring that all clinical disciplines take accountability seriously is laudable, but becoming responsive to the unexpected in the clinical workplace involves the development of competencies and expertise in problem recognition using deliberate practice, and building up a personal catalog of strategies that enable flexibility and adaptability in response to changing circumstances. Learning the basics of error theory, why people make mistakes, and how to prevent them is an academic solution for medical educators, not a practical solution for clinicians in the workplace who have little practical application for error theories.[42]

HAS THE EXCLUSIVE FOCUS ON RCA LED HEALTH CARE ASTRAY?

The introduction of RCA into health care tends to reinforce perceptions of adverse events as reducible to cause and effect, but it has also opened up a space for thinking about the clinical workplace that did not previously exist. Clinicians and managers on RCA teams are engaging in a more conceptual and reflective kind of thinking and talking than they routinely exchange in the operational environment of hospital wards and corridors. RCA teams differ in their interpretation of the incident investigation task but nearly all clinicians express frustration with linear sequencing in the RCA flowcharting exercise. RCA teams develop their view of a particular event by an iterative process, emerging through trial and error over the course of multiple meetings and is often the subject of ongoing debate and discussion beyond the timeframe of the RCA. The features of an adverse event that RCA team members recognize are a concurrence or coincidence[12] of different factors variously combined, but identifiable from similar events in their own clinical and managerial experiences. The past and present experiences of the RCA team members are crucial to the exercise of judgment when interpreting adverse events. The RCA findings are specific to a particular RCA team and group of clinicians with their own mix of habits and routines, conditions of practice, and context-related constraints and disturbances that they must negotiate and adapt to maintain the continuity of care.

CONCLUDING THOUGHTS

The search for causes of patient harm is pervasive in medicine but, when applied to understanding clinician behavior in response to changes in the clinical workplace, it tends to reduce the complexity and produce a reductionist approach of universal explanations independent of the clinical context.[12] The propensity to make general observations is increased by RCA teams because they have limited access to the people involved (usually a single informal interview weeks after the event) and are unable to observe the flow of context-sensitive continuous activity on the day of the event. The RCA team either makes plausible inferences or rejects the exercise outright and does something more meaningful with the RCA meeting space than selecting possible

causes. The collective response shifts to trying to make sense of the common experience of clinical work in similar situations.

On many occasions the RCA team decides that there is nothing causal in the event to report but determines to keep meeting anyway: there is a side effect to doing an RCA, which is that it gets people around the table to discuss and explore the deeper issues behind the event.[34] Making sense of what people do in situated contexts is a particular activity,[20] and nothing stimulates it like gathering a small group of clinicians around a complex set of issues. Recognizing the limitations of the RCA process but the associated benefits of structured sense making between clinicians, research by the Institute of Health Improvement (IHI) emphasizes "the importance of studying organizational resilience through structured conversations, in addition to conducting a root cause analysis of adverse events."[21]

We recommend that health care organizations allocate time and resources for surgical teams to participate in structured sense-making conversations with other clinicians. Making sense of complex interactions in the clinical workplace is an inherently concrete and local activity. Engaging frontline staff in this way provides a vital opportunity to scrutinize and improve current practice, influence how recommended actions from improvement activities (such as RCAs) are built into local routines, to identify unnecessary variations in practice, and set precedents for ongoing information gathering, observation, and control of action in the clinical workplace.[39]

There is much that can be learned and applied from the experience of structured clinical conversation during RCAs. The RCA meeting space provides the social context for reflective dialogue that is often hard to find in the midst of busy clinical routines.[43] The confusion and uncertainty around the adverse event provides a focal point for identification. A retrospective glance opens up the opportunity to review past assumptions and make new approximations of safe practice. The small episodes of clinical activity within the adverse event narrative provide cues to the RCA team that come from the edge of routine practice where the unexpected calls for a more flexible response. The situation in the adverse event is not isolated but part of the ongoing flow of clinical activity in the workplace, and the activity of reflection provides the RCA team with improved situational awareness (the individual clinicians in the event are not privy to this rich interaction or outcome). Reflecting on the adverse event helps RCA team members to collectively consider the plausibility of their own practice and routines. The experience of participating on an RCA team affords a small group of clinicians the rare opportunity of working out the best way to adapt to changes in the clinical environment through the enactment of the past adverse event.

A well-facilitated RCA team engages in a rich social form of clinical simulation through the opportunity to enact conditions that other people and other (local) systems have to cope with.[20] Similarly, junior bank tellers are taught to study legal tender notes in detail as opposed to trying to remember all the variations of counterfeit notes presented to the bank in the past. Knowing your clinical workplace and making sense of how your organization fits together and functions is perhaps a more reasonable goal than drafting more rigid rules and policies for preventing errors and controlling risks.

REFERENCES

1. Woodger JH. Causes and causal laws. In: Physics psychology and medicine: a methodological essay. London: Cambridge University Press; 1956. p. 98.
2. Bonacum D, Corrigan J, Gelinas L, et al. 2009 Annual National Patient Safety Foundation Congress: conference proceedings, Lucian Leape Institute town hall plenary: IOM report retrospective and the decade ahead. J Patient Saf 2009;5:131.

3. Bagian JP, Gosbee J, Lee CZ, et al. The Veterans Affairs root cause analysis system in action. Jt Comm J Qual Improv 2002;28:531.
4. Corrigan J, Kohn LT, Donaldson MS, editors. Errors in health care: a leading cause of death and injury. In: To err is human: building a safer health system. Washington, DC: National Academy Press; 2000. p. 26–48.
5. Barach P. The end of the beginning. J Leg Med 2003;24(1):7–27.
6. Streufert S, Satish U, Barach P. Improving medical care: the use of simulation technology. Simul Gaming 2001;32(2):164–74.
7. Berwick D, Rothman M. Pursuing perfection: an interview with Don Berwick and Michael Rothman. Interview by Andrea Kabcenell and Jane Roessner. Jt Comm J Qual Improv 2002;28:268.
8. Leape L. Is hospital patient care becoming safer? a conversation with Lucian Leape. Interview by Peter I. Buerhaus. Health Aff 2007;26(6):687.
9. Dekker S. New frontiers in patient safety. In: Patient safety: a human factors approach. Boca Raton (FL): CRC Press; 2011. p. 213–39.
10. Wu AW, Lipshutz AK, Pronovost PJ. Effectiveness and efficiency of root cause analysis in medicine. JAMA 2008;299:685.
11. Rittel HW, Webber MM. Dilemmas in a general theory of planning. Policy Science 1973;4:155–69.
12. Hollnagel E. Thinking about accidents. In: Barriers and accident prevention. Aldershot (United Kingdom): Ashgate; 2004. p. 36–67.
13. Montgomery K. The misdescription of medicine. In: How doctors think: clinical judgment and the practice of medicine. Oxford (United Kingdom): Oxford University Press; 2006. p. 70–83.
14. Barach P, Berwick DM. Patient safety and the reliability of health care systems. Ann Intern Med 2003;138(12):997–8.
15. Barach P, Johnson JK, Ahmad A, et al. A prospective observational study of human factors, adverse events, and patient outcomes in surgery for pediatric cardiac disease. J Thorac Cardiovasc Surg 2008;136(6):1422–8.
16. Small SD, Barach P. Patient safety and health policy: a history and review. Hematol Oncol Clin North Am 2002;16(6):1463–82.
17. Barach P, Moss F. Delivering safe health care. BMJ 2003;323(7313):585–6.
18. Vincent C, Aylin P, Franklin BD, et al. Is health care getting safer? BMJ 2008;337: a2426.
19. Iedema I, Jorm C. Report on RCA focus groups. In: The evaluation of the Safety Improvement Program, Study 7(b), the Centre for Clinical Governance Research in Health. Sydney (Australia): University of New South Wales; 2005. p. 18–9.
20. Weick KE, Sutcliffe KM, Obstfeld D. Organizing and the process of sensemaking. In: Weick KE, editor. Making sense of the organization, vol. 2. Chichester (United Kingdom): Wiley; 2009. p. 131–51.
21. Conway J, Federico F, Stewart K, et al. Respectful management of serious clinical adverse events, IHI innovation series white paper. Cambridge (MA): Institute for Healthcare Improvement; 2010.
22. Clarke LB. Some functions of planning. In: Mission improbable: using fantasy documents to tame disaster. Chicago: University of Chicago Press; 1999. p. 1–15.
23. Hollnagel E. Accidents and causes. In: Barriers and accident prevention. Aldershot (United Kingdom): Ashgate; 2004. p. 1–35.
24. Cassin B, Barach P. Balancing clinical team perceptions of the workplace: applying 'work domain analysis' to pediatric cardiac care. Prog Pediatr Cardiol, in press.
25. Dekker S. Theorizing drift. In: Drift into failure: from hunting broken components to understanding complex systems. Farnham (United Kingdom): Ashgate; 2011. p. 121.

26. Galvan C, Bacha EA, Mohr J, et al. A human factors approach to understanding patient safety during pediatric cardiac surgery. Prog Pediatr Cardiol 2005;20(1): 13–20.
27. Dekker S. The search for the broken component. In: Drift into failure: from hunting broken components to understanding complex systems. Farnham (United Kingdom): Ashgate; 2011. p. 76–8.
28. Bascetta CA, United States. General Accounting Office. VA patient safety initiatives promising but continued progress required culture change: statement of Cynthia A. Bascetta, Associate Director, Veterans' Affairs and Military Health Care Issues, Health, Education, and Human Services Division, before the Subcommittee on Oversight and Investigations, Committee on Veterans' Affairs, House of Representatives, in testimony; GAO/T-HEHS-00-167. Washington, DC: US General Accounting Office; 2000.
29. Montgomery K. Clinical judgment and the interpretation of the case. In: How doctors think: clinical judgment and the practice of medicine. Oxford (United Kingdom): Oxford University Press; 2006. p. 42–53.
30. Montgomery K. The idea of cause in medical practice. In: How doctors think: clinical judgment and the practice of medicine. Oxford (United Kingdom): Oxford University Press; 2006. p. 57–69.
31. Flin R, O'Connor P, Crichton M. Decision making. In: Safety at the sharp end: a guide to non-technical skills. Farnham (England): Ashgate; 2008. p. 45.
32. Bagian JP, Lee C, Gosbee J, et al. Developing and deploying a patient safety program in a large health care delivery system: you can't fix what you don't know about. Jt Comm J Qual Improv 2001;27:522.
33. Dekker S. Safety culture and organizational risk. In: Patient safety: a human factors approach. Boca Raton (FL): CRC Press; 2011. p. 99–110.
34. Dekker S. The legacy of Newton and Descartes. In: Drift into failure: from hunting broken components to understanding complex systems. Farnham (United Kingdom): Ashgate; 2011. p. 66.
35. Taitz J, Genn K, Brooks V, et al. System-wide learning from root cause analysis: a report from the New South Wales Root Cause Analysis Review Committee. Qual Saf Health Care 2010;19:1–5.
36. Percarpio KB, Watts BV, Weeks WB. The effectiveness of root cause analysis: what does the literature tell us? Jt Comm J Qual Patient Saf 2008;34:391.
37. Morrissey J. Patient safety proves elusive. Five years after publication of the IOM's 'To Err is Human,' there's plenty of activity on patient safety, but progress is another matter. Mod Healthc 2004;34:6.
38. Woloshynowych M, Rogers S, Taylor-Adams S, et al. The investigation and analysis of critical incidents and adverse events in healthcare. Health Technol Assess 2005;9:1.
39. Battles JB, Dixon NM, Borotkanics RJ, et al. Sensemaking of patient safety risks and hazards. Health Serv Res 2006;41:1555.
40. Apostolakis G, Barach P. Lessons learned from nuclear power. In: Hatlie M, Tavill K, editors. Patient safety, international textbook. Faithersburg (MD): Aspen Publications; 2003. p. 205–25.
41. Flach JM, Dekker S, Stappers PJ. Playing twenty questions with nature (the surprise version): reflections on the dynamics of experience. Theor Issues Ergon Sci 2008;9:125.
42. Wears RL. The error of chasing 'errors'. NEFM 2007;58(3):30–31.
43. Waring JJ, Bishop S. 'Water cooler' learning: knowledge sharing at the clinical 'backstage' and its contribution to patient safety. J Health Organ Manag 2010;24:325.