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REVIEW

Near-misses are an opportunity to improve patient safety: adapting strategies of high reliability organizations to healthcare

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Purpose of review
Near-miss investigations in high reliability organizations (HROs) aim to mitigate risk and improve system safety. Healthcare settings have a higher rate of near-misses and subsequent adverse events than most high-risk industries, but near-misses are not systematically reported or analyzed. In this review, we will describe the strategies for near-miss analysis that have facilitated a culture of safety and continuous quality improvement in HROs.

Recent findings
Near-miss analysis is routine and systematic in HROs such as aviation. Strategies implemented in HROs such aviation include the Commercial Aviation Safety Team, which undertakes systematic analyses of near-misses to assess and mitigate the problem and contributing factors, so that findings can be incorporated into Standard Operating Procedures (SOPs). Other strategies resulting from incident analyses include Crew Resource Management (CRM) for enhanced communication, situational awareness training, adoption of checklists during operations, and built-in redundancy within systems.

Summary
Health care organizations should consider near-misses as opportunities for quality improvement. The systematic reporting and analysis of near-misses, commonplace in HROs, can be adapted to health care settings to prevent adverse events and improve clinical outcomes.

Keywords
adverse event, aviation safety, healthcare improvement, near-miss, patient safety

CASE EXAMPLE

A 16-year-old girl presented to an outpatient surgery center for a routine otolaryngology procedure. After an uncomplicated surgical procedure, the patient was emerging from general anesthesia. The newly hired, locum anesthesiologist administered a medication from an unlabeled syringe with the goal of drying the patient's oral secretions, but tachycardia and high blood pressure ensued. A second, unlabeled, drug was given to control the blood pressure and cardiac arrest ensued. Anesthesia backup arrived and cardiopulmonary resuscitation was successful. Despite a delay in identifying the drug administered, resuscitation efforts were successful, and the patient recovered without any long-term sequelae.

INTRODUCTION

Near-misses – events in which harm is averted because of chance or intervention – can be red flags for impending failure. Indistinguishable from adverse events in all but the outcome, near-misses are viewed by high reliability organizations (HROs) as opportunities for quality improvement [1]. Experts estimate that near-misses occur 3–300 times more often than adverse events in healthcare settings [2], and that they typically precede a related adverse event. Despite the opportunity they provide for safety improvement, however, near-misses are under-reported in healthcare. The systematic

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KEY POINTS

- Near-misses are present in surgery, healthcare, and high-risk industries alike. These are indistinguishable from adverse events in all but the outcome.
- Adverse events and near-misses are poorly reported, squandering an opportunity for safety improvement.
- Aviation safety experts call for expeditious, blame-free reporting, root cause analysis, and seek quality improvement in the system, and not just an individual.
- Healthcare organizations can benefit from the principles discovered by these high-risk industries,
- including improved communication through CRM, which supports the diplomatic expression of a difference in opinion.

reporting and analysis of near-misses can improve system performance, mitigate risk, and prevent liability. Strategies implemented in HROs have facilitated the routine analysis of near-misses and can be adapted to healthcare settings to improve system performance, mitigate risk, and prevent liability.

HIGH RELIABILITY ORGANIZATIONS: A CONTRAST TO HEALTHCARE

High hazard industries such as aviation, nuclear power, and the military are routinely expected to perform highly coordinated, complex, technologically demanding processes with little error. In the late 1980s, a group of University of California researchers proposed the framework for limiting adverse outcomes and maximizing safety in High Reliability Organizations: 1) fostering redundancy of knowledge and skills within teams, 2) promoting a proactive environment for decision-making through improved communication, 3) advocating a culture of reliability, and 4) providing continuous training with incremental learning (Table 1) [1].

Table 1. Tenets of high reliability organization [Sagan, 1993]

1. Accidents can be prevented through good organizational design and management
2. Safety is the priority organizational objective
3. There is shared knowledge of how a procedure or function is accomplished (redundancy).
4. Promote a proactive environment for groups to make decisions that limit risks and improve communication (decentralized decision tree)
5. Advocate a culture of following through (reliability)
6. Provide continuous training and support
7. Improve gradually through trial-and-error learning

Most high hazard industries have applied this High Reliability Organizations (HRO) framework to eliminate catastrophic failures. This approach drives blameless reporting and proactive near-miss analysis, which may identify contributing factors such as barriers to communication and insufficient skill redundancy. The health care industry has been largely unsuccessful in attaining status as a HRO. Many health care organizations view near-misses as a reassuring sign of system success as harm was averted, but this hinders opportunities for continuous improvement and risk mitigation. Near-misses occur several times before an adverse event, and many preventable deaths have a history of preceding related near-misses [3,4].

A SYSTEMATIC APPROACH TO THE INVESTIGATION OF NEAR-MISSES IN COMMERCIAL AVIATION

The tenets of HROs are exemplified in commercial aviation. Established in 1997 as a partnership between government and industry to reduce US aviation fatal accident rates by 80% in 10 years, the Commercial Aviation Safety Team (CAST) has expanded into a global coalition that seeks to continuously reduce fatality risk worldwide [www.castsafety.org (accessed on July 27 2011)] [5]. This voluntary partnership was formed after the 1995 crash of American Airlines flight 965 into mountainous terrain in Colombia (Appendix 2, http://links.lww.com/COOH/A14). The tragedy of a functional aircraft in good weather being flown into the ground because of a series of human and system errors compelled the US government intervention into risk reduction in aviation.

CAST's working groups are comprised of multiple teams of technical experts that focus on analysis, implementation, and implementation measurement. With cooperation from key stakeholders in aviation, the CAST Analysis team undertakes extensive analyses of a specific accident category. Using accident investigation reports from authorities such as the National Transportation Safety Board, incident (i.e., near-miss) reports from airline investigations, voluntary reporting from crew and air traffic controllers, and computerized quick access recorders from aircraft, the team establishes a detailed sequence of events to determine what went wrong (the 'problem') and why it went wrong (the 'contributing factors'). The team develops interventions, rates their confidence that the intervention will solve or mitigate the problem, and evaluates worldwide applicability. An Implementation team then assesses the technical, financial, operational, scheduling, regulatory, and sociological feasibility of implementing

each recommendation of the analytic team, and devises a plan for implementation. Plans list precise actions to be taken by whom and when, along with the expected cost. Priorities are set according to perceived effectiveness and feasibility; interventions or safety enhancements with a high combined effectiveness and feasibility score are implemented first. Finally, the pertinent stakeholders in aviation commit to implement the safety enhancements within the expected timeline [5] (K. Olsen, personal communication).

Since its inception, CAST has moved from reactive investigations to proactive ones. Incidents are regarded with the same urgency as accidents themselves. The list of contributing factors from accident or incident analyses is used during the review of routine operations. If a factor that previously contributed to an accident or incident is present during routine operation, an intervention is designed to eliminate or mitigate the factor. The Implementation Measurement team develops a master safety plan, measures effectiveness of the intervention, and identifies future areas of study. By continuously monitoring the effectiveness of implemented actions and modifying actions for further improvement, CAST has built an effective framework for continuous quality improvement. Information sharing is considered an essential element of CAST's mission, and it accesses, queries, and shares information across 46 safety databases and 30 air carriers [5] (K. Olsen, July 2011).

In aviation, human factors have accounted for a vast majority of incidents and accidents [6,7] [http://accidents-ll.faa.gov (accessed on May 3 2015)]. As in flight 965, human factor errors have typically resulted from two contributing factors: a lack of situational awareness (the ability to identify and integrate critical information about the aircraft in relation to its surroundings) and the crew not following standard operating procedures (SOPs). As a means of improving situational awareness, CAST's interventions have led to the commercial development and adoption of technologies such as terrain awareness and warning systems in all registered aircraft in the US, installation of minimum safe altitude warning system in ground radar systems, and widespread adoption of training standards, including Crew Resource Management (CRM). CRM provides for team members from all ranks and positions to allow for diplomatically expressing a difference in opinion. This has been shown to improve communication in crucial times to improve safety, respective communication, delegation of tasks, and foster collective situational awareness [7,8].

CAST's approach to dealing with the problem of adherence to SOPs has entailed reviewing each SOP to ensure that it can be clearly understood and followed; developing new SOPs when required; having crew train to the SOPs; and penalizing crew that do not follow SOPs (Olsen, personal communication). These and other CAST safety enhancements – at the time of the interview, 76 in total – are partly credited for the decrease in rate of fatal aviation accidents from 0.05 to 0.022 per 100 000 flights, as well an annual reduction in aviation expenditure of $620 million per year.

APPLYING THE AVIATION MODEL OF NEAR-MISS ANALYSIS TO HEALTHCARE

The responsibility for patient safety has been fragmented within and across healthcare institutions with sparse information sharing. Because an analogue to flight recorders is not reasonable in most healthcare settings, the success of an integrated local and regional program will depend on reliable and factual reporting of near-misses, investigation, and implementation of patient safety interventions at the institutional and regional level. We propose a multifaceted approach to near-miss investigation and resolution (Table 2).

LOCAL INTERVENTIONS TO IMPROVE NEAR-MISS ANALYSIS AND RESOLUTION

The sheer number of near-misses in health care may serve as barriers to mandatory reporting. For pragmatic purposes, we suggest systematic reporting of only those near-misses that could have resulted in death or disability to the patient. By prioritizing the reporting and analysis of higher risk near-misses (e.g., those that may occur in the emergency room, operating room, or critical care units), organizations could maximize the potential yield of this process.

Built-in severity ratings with alerts for high scores can help triage time-critical safety hazards.

Leadership must support a culture that encourages the use of transparent, blameless reporting and full disclosure. The risk of litigation - a deterrent in

Table 2. Suggested approach to near-miss investigations

1. Mandatory reporting of all near-misses that could have resulted in death or disability
2. Rigorous, independent investigation by a team of experts independent of the healthcare institution
3. Results of investigation coupled with clear, feasible safety interventions
4. Healthcare institution held accountable for implementing safety interventions
5. Information sharing between institutions, regions, and states, ensuring widespread safety gains

the reporting of adverse events surrounding the near-miss. There are challenges to retrieve objective information about the events is absent when harm is averted so this could serve as a facilitator of a near-miss reporting. While physicians fear disciplinary action or ostracism from colleagues [9], reports could be de-identified once relevant information about the events surrounding a near-miss is collected for analysis. Other barriers in health care settings may include selective documentation of information pertaining to near-misses. For example, dictation notes about a surgical procedure would not typically include that a near-miss occurred. Encouraging all members of a team to document events in the chart and electronic storage and retrieval of charts may be a step to improving the quality of documentation and accessibility of data. Random non-punitive systematic audits of clinical encounters and patient charts may be a useful tool for detecting gaps in documentation may be a useful tool for detecting gaps in documentation.

A near-miss analysis is only as useful as the corrective actions taken to rectify the root causes. Therefore, it is critical that near-miss and error reports are not just processed at a database or local level, but are systematically reviewed by trained third party experts so that solutions are identified and changes implemented. Furthermore, the review needs to be disseminated to all parties that can benefit from the information, perhaps through the development of open-access registries and repositories - so that improvements can occur on a broader scale.

REGIONAL INTERVENTIONS

The value of private–public partnerships and regional coalitions in investigating near-misses, sharing information, and implementing the change requisite for consistently safe healthcare cannot be overemphasized. Coalitions are essential for the design and implementation of strong interventions (Appendix 3, http://links.lww.com/COOH/A14) that minimize risk to patients across diverse settings. A Public Private Partnership to Promote Patient Safety, involving alliances between the Agency for Healthcare Research and Quality (AHRQ), Food and Drug Administration, Joint Commission, US Pharmacopoeia, insurance providers, healthcare organizations, and industry safety experts could be formed [10].

It is suggested that sources of data for near-misses and error could include drug databases as well as data collected by the AHRQ [10]. We suggest that Joint Commission sentinel event alerts as well as complaints brought forward by patients could also serve as viable sources of information. Synergy within healthcare organizations can support these regional and national near-miss and error-reporting systems. Safety coalitions would provide their expertise in investigation and change implementation, and also shape public discourse and health policy. Tort reform and malpractice risks are keys to improving disclosures of error, but are not required to facilitate disclosure of near-misses as the latter – by definition – do not involve harm to a patient.

Progress to date

Near-miss reporting to date is hospital-based and anecdotal. However, there has been greater success with the adoption of CRMs and SOPs in high-risk health care settings healthcare settings. In the operating room, systematic checklists and ''time-outs are considered standard of care. Early results suggest success in reducing surgical complications with programs like 'The Safe Surgery Saves Lives initiative of WHO's Patient Safety Program', both domestically and abroad [13,14]. The effectiveness of teamwork and clinical decision-making has also shown measured improvement after CRM implementation in obstetrics settings and emergency rooms; CRM has also been associated with fewer adverse events and increased near-miss reports [15]. Although there are barriers to implementation of CRM and SOP, the time has come for healthcare organizations to implement strategies that have proven effective approaches in HROs and healthcare settings, alike.

The case

In the introductory surgical case, the root cause of the medication error included a series of human and system factors, which are not addressed by termination of the anesthesiologist. Contributing factors to the near miss may have included: 1) insufficient orientation of the locum anesthetist to the operating room SOPs; 2) deviation of the anesthesiologist from the SOP (failing to label syringes); 3) failure on the part of the nurses to speak up when they noticed the anesthesiologist's actions - a reflection of poor safety culture or inadequate CRM skills in the OR. Ideally, the hospital would implement changes that address the contributing factors and to prevent similar near-misses and avert an adverse events in the future. Findings could be shared between institutions and regions through an open-access registry that allows for improvements to be adopted on a broader scale.

Notable examples of other aviation-based improvements (CRMs and SOPs) have been applied in operating rooms. Systematic checklists (presurgical checks, timeout, and debriefing) are becoming standard of care. Surgical complications have been reduced with programs like 'The Safe Surgery Saves Lives

initiative of WHO's Patient Safety Program', acting both domestically [13] and abroad [14]. CRM implementation in obstetrics settings and emergency rooms has improved teamwork, perceived communication, fewer adverse events and increased near miss reporting [15]. In a recent survey, surgeons, trainees, and the operating room staff agreed that aviation safety principles used in surgery reduce errors [16▪▪]. Lastly, along with surgical checklists, operating team efficiency is being investigated when consistent, standardized teams are used in complex microvascular surgeries with early success [17▪▪,18▪].

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Conflicts of interest

There are no conflicts of interest.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

- ▪ of special interest
- ▪▪ of outstanding interest

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17. ▪▪ Schelkun SR. Lessons from aviation safety: ''plan your operation – and operate your plan!'' Patient Safety in Surgery 2014; 8:38. http://www.pssjournal.com/content/8/1/38.

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18. ▪ Doherty C, Nakoneshny SC, Harrop AR, *et al.* A standardized operative team for major head and neck cancer ablation and reconstruction. Plast Reconstr Surg 2012; 130:82–88.

The rationale for checklist implementation in surgery is detailed. Other effects on participants are described such as recognizing their own role in strengthening patient safety and encouraging multidisciplinary teamwork.

AQ1 **Uncited references**

[11,12].

AQ2

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