IMPROVING PATIENT SAFETY: A MODEL OF DRIFT IN HEALTH CARE TEAMS

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ABSTRACT
Rasmussen & Cook (2005) provide a framework for developing a model of risk management to improve patient safety by applying systems dynamics modeling to understand team performance and how it drifts from best practices. Drifting into failure is not so much about individual deficits as it is about organizations not adapting effectively to the complexity of their structure and environment (Dekker 2005). Expanding the conceptual model using the taxonomy of the medical domain to more fully define the interconnections of individual and team performance, risk assessment, management of resources, and recognition of the limits of team workload and maintenance of high performance is an essential next step. Lamb, et. al. (2010) indicates the usefulness of modeling drift in the naval domain. This paper summarizes research underway to develop a health care team specific model of drift. This model characterizes the sets of factors that influence team performance boundaries, identifies and describes team performance and decision making behaviors that determine the size and positioning of the team operating space, a concept developed within the model. A dynamic system will then be described in a manner that can serve as the basis for the development of a variety of simulations intended to improve team performance, maintain high performance over time, and thus improve patient safety.

Keywords: operating room, human error, risk management, team performance, medical errors

1. INTRODUCTION

Human error is often cited as a cause of errors occurring in the operating room. As an explanation, it is a time honored practice to place blame on *human* error, and it is strikingly similar to practices in other professions, most prominent among them civilian aircraft accident investigations, but also within many military organizations, both U.S. and international. Such assignment of cause to human mistakes provides both a concise and remediable explanation of what went wrong. However, root causes are rarely, in truth, so readily compartmentalized into categories – others include material failure, unexpected patient complications, etc. While the human component of failure is certainly present, there are others factors at work. Sidney Dekker [Dekker, 2005], a long experienced aviation analyst, introduced, in his book, "*Ten Questions About Human Error: A New View of Human Factors and System Safety*", the concept of "drift into failure" to explain aviation accidents. His assertion is that the root cause of human performance failure is frequently an unintentional "drifting" away from best safety practices over time due to pressures of mission, schedule, etc. And this drift is often subtle, not noticed by members of the performance team experiencing such drift.

Recent studies of naval mishaps lend credence to Dekker's concept, when applied to large team performance. Lamb [Lamb, 2010] and others, based on study of recent naval mishaps, have hypothesized the characteristics of drift for performance teams on long maritime missions. Based on this study and concepts from Rasmussen (1997), they developed a conceptual model of the forces acting to increase the likelihood of a mishap. Their model "provides a framework for ship managers and higher levels of command to better evaluate the current dangers and take actions to reduce them before crew drift meets a golden opportunity for a mishap."

This characterization of human performance and human error applies as well to medical practice.

2. THE PROBLEM

2.1. Making the Analogy to Medical Practice

A hospital surgery operating room (OR) is an exercise in highly precise, orchestrated, and monitored execution of complicated and complex procedures, often of high risk, directed by a designated leader guiding the activities of a specialized team, each functioning as a member of a hierarchical organization. This team's focus is on execution of one major objective (and at times simultaneous sub-objectives), in a time stressed and decision stressed environment. At times, the lead surgeon must make important decisions affecting risk to the patient in real-time, with partial and/or ambiguous information. Successful surgical outcomes depend on a combination of surgeon's skills, detailed understanding of the patient's condition, proper execution of all support operations and procedures, and a sequence of correct decisions by all members of the team. Missteps, poor decisions, decisions not made, and loss of situation awareness can each contribute to "drift" from best-possible-practice, and can occur without notice by either the lead surgeon or individual subordinate team members.

2.2. Risk Management – Seeing Risk in Real Time

In many fields, Operational Risk Management (ORM) is supposed to address issues like those found in analyzing naval operations mishaps. However, for humans performing in complex and ambiguous situations, traditional ORM procedures do not provide an effective solution. What is lacking is some way, some methodology, or some mental approach that serves to get all team members on the same page, at the same time, and conscious of existing and potential risks arising in execution of intended tasks or operations. It is our contention this can best be accomplished by creation and implementation of a simple model, analogous to that proposed by Lamb et al, that sees through the complexity and details of high risk patient procedures, and provides a tool to help performers – whether surgeons, naval commanders, or disaster response team leaders - "see" the overall operating situation and correct for drift.

Cook and Rasmussen [Cook, 2005, Cook and Rasmussen, 2005] have described a theory of patient safety in terms of the coupling of technologies and staff in the context of high stakes medical practice, and related loss of safety to the loss of margins, or buffers, to safety limits. The essence of the argument is that when people, technologies, and schedules are tightly coupled, with scant margin for variation, errors and mistakes result from 'going solid', a condition analogous to operation of pressurized water nuclear power plants. The condition is one in which very small perturbations (in water pressure for a nuclear plant; in sequencing patient care action in an ICU) can cause unintentionally large, and often not anticipated, excursions in important parameters.

Naval operations are often an equivalent exercise in highly precise, orchestrated, and monitored execution of complicated and complex procedures. The organization is hierarchical, the procedures difficult, and time and decision pressures intense. In submarine operations especially, in which the hierarchical organization is in many ways a mirror image of a surgical team, effective team interaction and mutual understanding of risks present are essential to sustainment of error-free operations. Where drift occurs from best-possible-practice, opportunities for mistakes multiply, creating opportunity for significant mishaps – the equivalent of medical errors - to occur.

The difference between such team operations in the naval domain and team operations in the surgical domain is team practice, or team rehearsal.

A recent spate of naval mishaps, especially collisions and groundings, has been perplexing and extremely frustrating for those involved. Examples include the underwater collision of two submarines, one French (Le Triomphant) and one British (HMS Vanguard), in the middle of the Atlantic; the grounding of a United States surface warship ship (USS Port Royal) on a reef near Honolulu; and the collision of a United States submarine (USS Philadelphia) with a Turkish merchant ship off the coast of Bahrain.

While these specific mishaps seem to show no discernible pattern in terms of location, circumstance, or ship type, a relevant question is, "could they actually have something in common?" Rasmussen's concepts of 'drift' would argue that it is NOT the case that each naval mishap is a one-in-a-million event that could never have been predicted and can never happen again.

There have been at least 10 major mishaps involving submarines (U.S., UK, and France) since 2000. A review of mishaps involving U.S. submarines in the past 10 years revealed that in all cases there was no single, simple underlying cause. In fact, many errors were found to be subtle and cumulative and, thus, very hard to see. The crews were performing normal tasks in a normal situation. In many reports, it was apparent that the crew's decisions made sense to them in real time and that the mistakes made were not recognized at the time. It seemed to be the case that the crews "drifted" into their eventual troubles. After the fact, during mishap reviews, with the advantage of hindsight, investigators found mistakes, procedural violations, and deviation from best-possible-practice.

Similarly, in review of medical errors, investigators can find mistakes and violations of procedure not seen by OR teams during the course of surgery.

2.3. Drift into Failure

The notion of drift, or drift into failure, was originally developed by Dekker to explain aviation accidents. Dekker [Dekker 2005] defines drift into failure as the "slow, incremental movement of systems operations towards the edge of their safety envelope." This concept can be leveraged to help us understand what could be working to potentially undermine a normally safe, highly complex, sociotechnical system – such as exemplified by surgical OR teams or the command team of a nuclear submarine.

In terms of risk to safety, 'drift' is this accumulation of unintentional, typically minor, human errors and/or procedural violations. As Dekker has pointed out, drift is the "greatest residual risk in today's safe sociotechnical systems." The naval mishap research revealed that crews were often surprised by their bad outcomes; they never saw it coming. Those same crews also had ample time to invoke a process like ORM, yet, in trying to deal with the complexity and ambiguities of situations they found themselves in, they typically did not (or could not) see the situation for what it really was.

2.4. The Missing Piece

While Dekker's model has much to offer, it does *not* address what is really needed: the development of a practical tool that can be used *proactively* to prevent drift and improve safety. A limitation of the "drift into failure" model is the 'failure' part. Evaluating human performance based on after-the-fact outcomes is too late; recognizing trends – drift - during process/procedure execution is what's missing. A reasonable hypothesis is that performance drift is always present to some degree; at minimum, it must always be expected. An important question is thus: How can health care workers recognize drift in time to correct mistakes before they lead to serious error?

Rasmussen [Rasmussen, 2000] describes a proactive strategy to risk management that is based on:

- Identification of the boundaries for safe performance,
- Efforts to make these boundaries visible to decision makers, and
- Efforts to counteract pressures that drive decision makers toward the boundaries.

His dynamic model of risk and safety can be used to formulate a model of OR safety.

The model is not singly focused on traditional definitions of safety, but rather incorporates a complete system of safety and the various pressures that can contribute to 'un-safety', and thus mishaps.

Based on some initial work, we've identified three boundaries for safe OR performance: Team proficiency/experience, patient physiological condition, and team workload. The extent to which a team can stay within these boundaries determines how much drift the environment (OR) and its team can tolerate without failure (*i.e.*, 'drift limits'). Figure 1 depicts this concept.

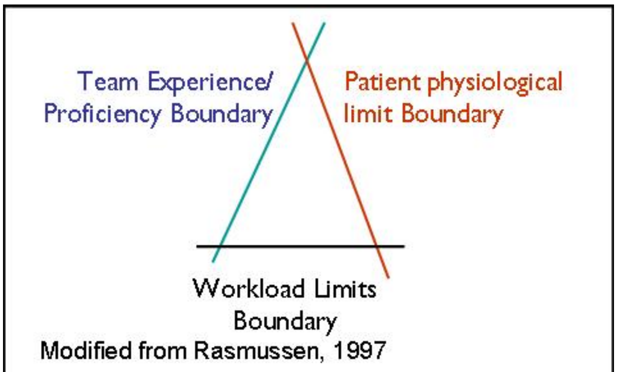

Figure 1: OR Performance Boundaries

The triangular area represents an 'operating envelope'; its size is situation-specific and is, therefore, a function of how constraining each of the three boundaries is at the time. The boundaries become more or less constraining depending on the specific details of the surgery /procedure.

Each failure boundary position is set by a number of factors. The workload failure boundary includes rew sleep characterization, fatigue, competing tasks, distractions, etc.

If the boundaries represent the limits of safe operation, then the model must provide a way to determine whether or not the team is inside or outside those limits. Determining this requires an understanding of the current team's *expected* performance level. The term 'functional capability' is used in this context to represent the variability of expected, and allowed, surgical team performance. In terms of the diagram of Figure 1, this 'functional capability' is illustrated by use of a circle placed within the triangle of limits. The capability circle is shown in Figure 2.

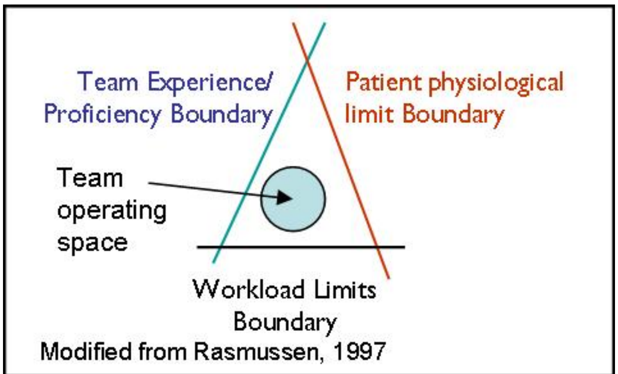

Figure 2: Team Capability vs Limits

The smaller the circle, the less performance is expected to vary; the circle's distance from boundaries is a qualitative indicator of existing buffer, or margin, to the limits shown. The functional capability – the circle's size and positioning – is driven primarily by individual and team skill, experience, and proficiency in execution of the procedures for which the performance boundary diagram applies.

In terms of risk in the Operating Room, "drift" is an unintentional accumulation of human errors and/or procedural violations, each of which are typically minor. In the naval domain research of Lamb et al, it was clear that skilled, experienced watch team were almost always surprised by their bad outcomes. And the mishaps occurred to crews who practiced ORM, who trained and practiced together, and who had all the technology at hand to help avoid errors, mistakes, and bad outcomes. What seemed common to many of the mishaps was that watch teams, in trying to deal with the complexity and ambiguities of the situations they found themselves in, could not see the situation for what it really was.

2.5. Reducing Error in the Operating Room

This research suggests that what may be of benefit to surgical teams in the OR is development of a surgical team specific drift model - one that characterizes the sets of factors that influence the OR Performance Boundaries of Figure 1, and research to identify and describe the team performance and decision making activities and behaviors that determine the size and positioning of the Team Operating Space as illustrated in Figure 2. Just this research in a naval domain has proven useful as a way to improve team members' self awareness of the performance relationships and pressures influencing real time behaviors and decision making. It is suggested here that focused research to characterize and develop a surgery team specific OR Performance model, with parallel (and related) research understand and characterize individual surgical team member behaviors and activities in terms of the Team Operating Space and its approach to Performance Boundaries would contribute significantly to initiatives focused on reducing errors in the OR, and in improving patient outcomes.

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