When Lightning Hits Your Spaceship: the Power and Peril of Habits in Aerospace and Patient Safety

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INTRODUCTION: PARALLEL UNIVERSES

Medical errors are substantial sources of morbidity and mortality.¹ Despite intense scrutiny and efforts over the past two decades, errors remain ubiquitous.² Safety deficits in medicine occur due to gaps in knowledge, clinical decision-making, judgment, or communication skills.³ Whether recognized or not, many ingrained habits form the basis for clinical care by individuals, teams, and organizations. Successful safety practices are often, in essence, appropriately implemented repetitive skills (i.e., habits). Yet, while habits can help facilitate safe and effective practices, there are perils in relying on them—and when used incorrectly they may lead to suboptimal care and outcomes.

But how do we learn to recognize bad habits and institute better habits? In the past, parallels between healthcare and the aerospace industry have illustrated learning situations beholden to both settings because errors can be costly and have very negative, even lethal, consequences.⁴ Furthermore, aerospace and healthcare team members need agility in habits and actions, adapting to different situations. Hence, there are important crossover lessons that medicine can learn from aerospace about the perils of habits. Using anecdotes from the space age, based on one author's personal experiences (TW), we briefly illustrate three such lessons.

ANECDOTES FROM AEROSPACE

“Bottles Don’t Float on Earth”

SkyLab was the USA's first space station, spanning three manned missions. After the third manned mission, lasting about 3 months, one astronaut found a minor problem in

re-acclimating to Earth—he found himself dropping things. In space, astronauts learn that everything floats, allowing placement of objects in the “air” while performing tasks. Back on Earth, the astronaut continued the habit, not infrequently opening the refrigerator and removing a milk bottle—and then letting it go while getting a glass.

The consequences of gravity being obvious, a useful habit developed in outer space necessitated adjustment on Earth. Similarly, contextual shifts in clinical care sometimes require adjustments, as became abundantly clear during the current pandemic whereby habits developed over years of in-person practice necessitated changes to safely transition to a more extensive virtual care environment. For example, habits about performing physical examinations and ordering tests needed to be re-examined. Clinicians need to now decide when these actions are necessary for safe and effective care, balancing that decision with the risks of the pandemic. No doubt, many of these changes will be reflected in future healthcare management.

“Gamma Ray Observatory”

The Gamma Ray Observatory, designed to detect gamma rays and other extraterrestrial electromagnetic energies, was launched from Space Shuttle Atlantis on April 5, 1991. During deployment, data from the spacecraft to the NASA Goddard Space Flight Center was lost, halting satellite activation activities. An engineer at Goddard believed that this was due to a configuration problem on the space shuttle and suggested corrective action to Goddard personnel. However, the instructions for that action involved a complex switch name, with six people in the chain of command needing to relay communications from Goddard via the Houston Mission Control to the astronauts. A quick decision was made to have the engineer speak directly to the Houston Flight Director who then had the action relayed to the astronauts, correcting the problem almost instantly.

In disrupting the team's usual communication protocols, the flight director ensured the message was relayed

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efficiently and correctly. Similarly, timely, effective, and error-free communication is a critical component of safe healthcare. In many situations, such as low-risk routine care, indirect, asynchronous, unidirectional communication between providers, such as forwarding progress notes, or to a patient, such as sending a letter, suffices. However, clinicians must recognize when communications should be direct, timely, potentially synchronous, and bi-directional, such as having a telephone conversation, to assure that the message is received as intended.

“SCE to Aux”

Apollo 12, the second mission to the Moon, launched on November 14, 1969. Seconds after liftoff, and unknown to the mission team at the time, the vehicle was struck by lightning, setting off numerous alarms and scrambling all data readings. Mission Control and the astronauts struggled to assess and respond to the situation as flight controllers were at a complete loss without data from the spacecraft. Mission Control Engineer John Aaron, recalling a similar event during a simulator exercise, relayed a relatively obscure recommendation to the Flight Director for the astronauts to set “SCE to Aux.” This rarely used switch was on the overhead panel in the command module (Fig. 1). The message was sent from Mission Control—and astronaut Alan Bean, sitting nearest the switch and who knew its location, effectively rebooted the spacecraft. Data and systems came back online, mission abort was averted, and the Apollo program’s second Moon landing was ultimately successful.

Despite the team’s building trust and experience (e.g., successful habits) during extensive pre-launch simulations, an unexpected hazardous situation occurred. Group knowledge and trust allowed them to break usual operational habits, which relied on spaceflight data, to save the mission and crew. Such rapidly evolving, unpredictable, and mission-critical yet rarely encountered situations are not

unknown in healthcare, for example, a complication during a cardiopulmonary resuscitation (e.g., inability to obtain an airway). During team-based resuscitations, clinicians rely on their shared knowledge and training, including simulation exercises, to work cohesively. However, in the face of an unexpected complication, individuals’ troubleshooting ideas and skills, rather than ingrained habits, may save a patient.

DISCUSSION: THE POWER AND PERILS OF HABITS

Habits are powerful tools for promoting quality care in medicine, often facilitating rapid, safe, effective, and coordinated actions. Frequent practicing and/or utilization of such skills is crucial for maintaining good habits. Of course, in both medical practice and aerospace, new evidence (data) is a primary foundation and impetus to developing appropriate habits. Yet, it is sometimes difficult to discern when habits should be questioned and changed. What works in one place or with one person or team may not work well in different clinical environments or practice situations.

One lesson is to be conscious about how and why habits form. Dual Process Theory from cognitive psychology describes how humans use two types of thinking: automatic, unconscious, thinking (i.e., habits) and controlled, conscious, thinking. Automatic thinking requires minimal mental resources and is therefore efficient—mental “shortcuts” are inherent to automatic thinking and these shortcuts often allow for good, consistent practices such as choosing the correct antibiotics for community acquired pneumonia or performing successful cardiopulmonary resuscitation. When there is a change in context—setting, situation, or evidence—it is important to switch from habituated processes to controlled conscious thinking until the problem is solved and/or new habits are formed, as appropriate.

Almost all healthcare providers will encounter situational and practice changes. The current COVID-19 pandemic is a recent example but it likely will not be the last. Being

Fig. 1 Apollo 12 Command Module. Image from the Smithsonian National Air and Space Museum, modified by Eduardo Garcia Llama⁵

cognizant of habits, and having the tools at hand to deal with complex, changing situations, allows us to function and change more effectively, sometimes consciously thinking outside established norms. Crossover lessons from aerospace can teach us that, at least in this universe, safety is predicated not always on what we know but also on the habits that we form. Learning when habits should be changed or adjusted is another skill, especially if your spaceship gets hit by lightning.

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Declarations

Conflict of Interest The authors declare that they do not have any conflicts of interest.

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