Error Reduction through Team Leadership: What Surgeons Can Learn from the Airline Industry

Jack Barker, Ph.D.

About 1815 PST on December 28,1978 Flight 173 crashed into a wooded, populated area killing 8 passengers and 2 crewmembers, and seriously injuring 21 passengers and 2 other crewmembers. The National Transportation Safety Board determined that the probable cause of the accident was the failure of the captain to monitor properly the aircraft's fuel state and to properly respond to the low fuel state and the crewmembers' advisories regarding fuel state. This resulted in fuel exhaustion to all engines. Contributing to the accident was the failure of the other two flight crewmembers to fully comprehend the criticality of the fuel state or to successfully communicate their concern to the captain.

The Safety Board believes that this accident exemplifies a recurring problem—a breakdown in cockpit management and teamwork during a situation involving malfunctions of aircraft systems in flight.

—National Transportation Safety Board (1979)[14]

AVIATION SAFETY CULTURE CHANGE

Flying is considered a high-risk endeavor. Through the years, improvements in technology have reduced the risks associated with flying, but aviation accidents have not been eliminated. After several costly and preventable high-profile crashes in the 1970s that were not a direct result of equipment failure, the science of Crew Resource Management (CRM) was developed.[21] The airline industry recognized that human factors was a causal factor in many of the accidents and developed CRM, which teaches teams to make optimum use of all available resources—equipment, procedures and people—to promote safety and enhance the efficiency of flight operations.

Some of the nontechnical factors contributing to several accidents included crew fatigue, crew status differential, lack of assertiveness, communication issues, leadership problems, and noncompliance with standard operating procedures (SOP). Because of numerous aircraft accidents not related to mechanical failures, United Airlines developed and instituted the first CRM program in 1979 integrated with their ongoing simulator training.[9] They used a novel training concept called line-oriented flight training (LOFT), which involved a complete mission without interruption during simulator training. Previous training was focused more on the individual pilots' technical skills and their ability to effectively deal with several different contingences simultaneously, which was not very realistic. The LOFT scenarios were realistic, requiring the crew to work as a team to complete the missions safely. Using simulation to access technical skills alone was not a guarantee of safety in the real world environment. LOFT scenarios created subtle problems requiring pilots to work as a team to successfully reach a safe conclusion to the flight. These scenarios were modeled after actual incidents that, depending on the crew's teamwork and decision making, could result in either a safe landing or a catastrophe. The scenarios allowed for either result, depending on the crew's performance. This enabled the crews to use their newly developed CRM skills, and realize the benefits of successfully using CRM skills.

The evolution of CRM training in aviation began with only captains participating in the training program. This helped to open communications in the cockpit, but barriers still remained, such as the reluctance of subordinate crew members to be assertive at times. Next, all pilots were included in this training, which led to improved teamwork and communications in the cockpit. In 1986, an Air Ontario flight crashed shortly after takeoff because of ice accumulation in Dryden, Canada. The investigation revealed that the flight attendants might have prevented this accident by conveying information from the passengers concerned with ice on the wings to the captain.[8] The accident board recommended that flight attendants receive CRM training. Ultimately, the best way to train a team is as a team. Flight crews attend annual training, and team training works best when the pilots and flight attendants train together.

DOES CRM WORK?

The aviation industry has dedicated training resources during the past three decades to safety programs and, in particular, CRM. Does CRM decrease errors and reduce accidents? Airline accidents are an infrequent event, with

0148-703/07/5401-0195

only 2.6 accidents per million flight hours occurring in 2001,[15] making for criteria that are difficult to study via the scientific method. Controlled studies, such as implementing a CRM training program at airline X and not at airline Y, then comparing their accident rates a few years later, go against Federal Aviation Administration regulations and commonsense. We are left with anecdotal evidence that CRM initiatives improve safety.

Figure 31.1 (3) summarizes the impact of CRM training on accidents by several flying organizations. A significant reduction in accidents occurred in these disparate organizations after CRM training. Additionally, since United Airlines began CRM training, it has not experienced any crew-caused accidents. The National Transportation Safety Board report on the United Airlines DC-10 that crashed landed in Sioux City in 1989 stated that the flight crew interactions were "Indicative of the value of Cockpit Resource Management Training."[3,16]

Figure 31.2 illustrates an important consideration for organizations that attempt to change their safety culture using CRM concepts. The US Army initiated their CRM training, called Aircrew Coordination Training in 1994 for both their fixed wing aircraft and helicopters. This program only included a one-time training event with no continuation or refresher training. The following year's results showed a significant decrease in overall accident rates. By 1999, the accident rates had increased back to baseline. Therefore, any attempt to use CRM training should contain a comprehensive plan to reinforce and build on the initial training.[7]

AVIATION SAFETY TOOLS

CRM became the cornerstone of most aviation safety programs, including the military, during the 1980s. Other aviation safety tools have been developed in conjunction with CRM or as a result of information learned after a major accident. These include checklists, briefings/debriefings, SOPs, error reporting systems, simulation, and line observations safety audits (LOSA). The combination of CRM and

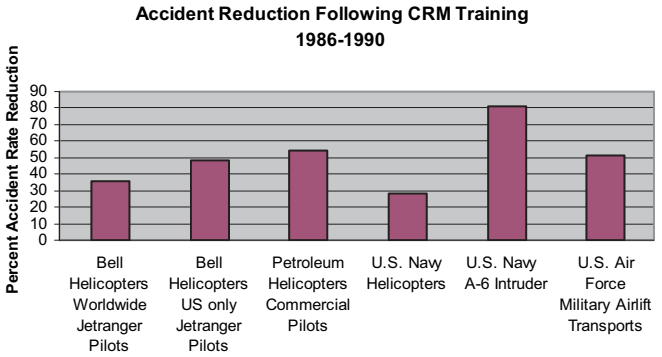

FIGURE 31.1. Impact of various CRM training programs on accidents.

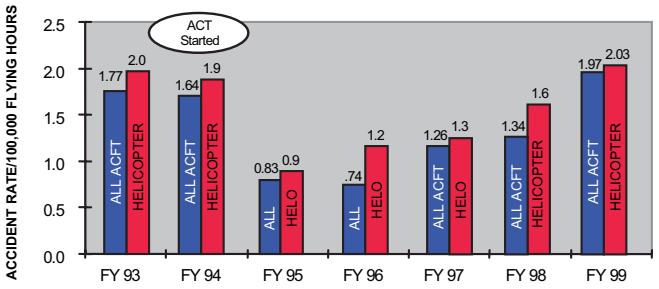

FIGURE 31.2. Army aviation accidents by year, 1993 to 1999. ACT, Aircrew Coordination Training; Acft, aircraft; helo, helicopter.

effectively using all other aviation tools has helped to make aviation one of the safest industries.[2,9] Next, we will describe these aviation safety tools in depth.

CRM Training

Most training programs incorporate various CRM principles along with other aspects of team training. These other areas may include understanding error chains and how to break them, stress management, understanding and learning to control hazardous attitudes and behaviors, risk management,[3] and interpersonal skills.[12] The training methods used for CRM training include didactic instruction, role playing, case studies, and simulation.[11] There is a wide variation among both aviation and healthcare CRM programs. These programs should be customized to each organization's culture. Many organizations are performing some components of teamwork well and training should build on an organization's existing strengths.

Checklists

Checklists are communication tools that ensure attention to mission-critical items that need to be performed. For the most safety-critical items, the concept of dual concurrence is used. Two people must independently verify an item is completed to satisfaction and report that fact to each other. The person charged with completing an item does it and subsequently the item is verified as completed by the checklist.

Checklists open a two-way flow of communication between the team leader and members. Most checklists use the challenge and response method. Typically, junior team members are charged with the responsibility of challenging the team leader and the team leader or other appropriate person replies that the item is completed to satisfaction. This allows junior members a system-designed way of questioning a leader without making a personal affront or seeming insubordinate. Checklists are an aid to reducing errors, but even the best checklist is useless if not used. Many individuals might refuse to use a checklist or only partially follow the checklist because they think that they do not need it.[23] An organization

with a mature safety culture mandates that checklists are used all the time and followed completely. The experience in aviation is that a complacent safety culture that leaves the checklist unused is the culture more prone to error.[15]

Briefings and Debriefings

Briefings are a powerful skill in building a team dynamic and allow different types of people to work effectively together during normal duties and during contingencies. Briefings establish who the team leader is and are used to define roles and responsibilities for each team member. A positive team climate is established during the brief, opening up lines of communication and setting the tone for the upcoming procedure. Protocols are discussed, and learning is reinforced. Responsibilities and expected behaviors are discussed. Misconceptions can be cleared up before they interfere with the accomplishment of the mission. During the team briefing, possible contingencies are discussed. Teams that discuss potential problems ahead of time perform better even when an unexpected, unbriefed problem occurs, because briefings create a culture within the team that facilitates exchange of communication and ideas.[6]

After-action debriefings are an excellent method to improve team performance. Once the team has completed their task they should spend a few moments reviewing their performance and learning how they can perform better the next time. A debriefing involves reviewing what went well, suggestions for improvements, and a review of the team's communication. During debriefing, the focus should be on the team and not on individuals. The goal is not to blame individuals but to improve both individual and team performances.

SOPs

SOPs are the painted lines of teamwork. When one is driving down the highway, the painted lines we follow delineating individual lanes were designed by traffic engineers to give us the safest path to our destination. So it is with SOPs in a particular operation. Engineers, researchers, and analysts study the data and develop procedures and best practices that yield the best possible outcomes. When we follow SOPs, we achieve success more often then when we do not use a proven system.[17,23]

Do SOPs require slavish and rote movement? Absolutely not, as tacticians practicing in the real world every day, we are still expected to draw on all our knowledge, expertise, and judgment, but following SOPs makes our lives easier. We follow a well-delineated path, reserving our limited cognitive resources to coordinate the efforts of our team and resolve contingencies.

An additional and very important benefit of SOPs is that the entire team is expected to follow these well-defined procedures. Everyone has an expectation concerning procedures and when a person deviates from the expected path and ventures into potentially unsafe territory, others can note the protocol violation and are able to advocate a return to the expected SOP.

Error Reporting Systems

Adverse events do not happen without warning. Usually, a series of errors lead up to the event. Referred to colloquially as "the holes in the Swiss cheese lining up," this concept applies at the individual level and at the macro level.[20] Error reporting systems are nonpunitive mechanisms that allow for the identification of undesirable trends or safety problems visible only to those at the front line. In aviation, these reports go to a committee comprised of Federal Aviation Administration inspectors and members of airlines and union safety committees. The system is nonpunitive as long as people self-disclose and the error was unintentional; a tremendous amount of valuable data has resulted from this system.

If trends are recognized and dealt with, an accident can be averted. For example, in the late 1980s, United Airlines noticed a trend of airplanes making navigational errors at night or in bad weather and coming dangerously close to mountains while descending into airports. They changed their navigation protocols and saw the trend recede. Another airline had the same trend but took no action and lost two airplanes during the next 5 years because of collision with high terrain. In a more recent example, trend monitoring during the past few years predicted that the next major accident would involve a runway intrusion. The recent Comair crash in Lexington, Kentucky in July 2006 most likely was a result of a pilot losing situational awareness while taxiing, being confused about the runway assignment and position on the airport, and taking off on the incorrect and too short runway.[5]

Simulation

Aviation has been using simulators for the past 50 years. At first, they were used to practice crisis-type emergencies that were too dangerous to practice in the airplane, such as engine failure or a tire failure on landing. Since the early 1990s, they have been used to train and evaluate teamwork and leadership skills. Oftentimes training and evaluations consist of a virtually normal flight, so that the crew can learn how to work together in normal environments, deal with small problems, and learn how to stop them before they turn into a crisis.

LOSA

In LOSA, neutral third-party observers ride in the cockpit and observe the crews for compliance with protocols and identify any dangerous trends. Major accidents are a rare event (see *Fig. 31.3*) representing the tip of the iceberg. Organizations that commit more errors than others are more

FIGURE 31.3. Accidents are only the tip of the iceberg.

likely to have a catastrophic event. By analyzing the LOSA data, an organization can make system changes to avert major incidents.[10]

HEALTHCARE CRM

During the past 10 years, there have been several attempts to port aviation safety practices, including some aspects of CRM, to healthcare. One of the first programs involved team-based collaborative rounds at Concord Hospital, Concord, New Hampshire.[22] The results of this program included a 50% decrease in mortality rates for cardiac surgery patients, patient satisfaction rates above the 97th percentile nationally, and an increase in provider quality of work life. Another study found that teams practicing good leadership and team skills learned new procedures faster than other teams.[4] At Johns Hopkins, in Baltimore, Maryland, the average length of patient stay in the ICU was reduced by 1 day by improving communication through the use of daily patient goals.[19] Beth Israel Deaconess Medical Center in Boston, Massachusetts had a 53% reduction in adverse events for their obstetrics department after team training.[1] The results are encouraging, although the adaptation of aviation safety practices to healthcare is a relatively new paradigm. More research is necessary to determine the efficacy of these programs and to help determine what specific aspects of aviation safety will enhance patient safety in healthcare.

CONCLUSION

Many authorities have suggested that aviation safety concepts can help reduce errors.[13,18] Almost 30 years ago, the aviation industry realized that technical proficiency alone could not prevent accidents. Mishap investigations suggested that a breakdown in communication and teamwork was a causal factor in many accidents. Aviation embarked on a quest to change its culture of safety by implementing CRM programs, improving checklists and SOPs, implementing safety-reporting systems, and continuously developing aviation safety tools. Autocratic behaviors in the cockpit that were considered acceptable, even lauded, 20 years ago, would now make one an outcast among peers. Today, even the most hardened, grizzled veteran would say, without equivocation, that these modern human behavior standards, despite the initial cultural and sometimes visceral resistance, have made aviation a more progressive and safer industry. The culture of safety has changed in aviation.

Multiple healthcare organizations have implemented aviation safety concepts with successful outcomes. The safety culture of our medical community is often equated to the safety culture that existed before the introduction of CRMs to aviation. It has been almost 30 years since the first CRM programs were developed and implemented in the airlines. The process of culture change is difficult and requires time. The medical community has begun the long process of changing its safety culture, which may take decades to complete.

REFERENCES

1. Anonymous: Ob-Gyns investigating model reforms to avoid medical error. **Managed Care Weekly Digest** May 24, 2004. Au: Please include publication information and authors for Reference 1.—Copy editor.
2. Baker DP, Gustafson S, Beaubien J: *Medical Teamwork and Patient Safety: The Evidence-Based Relation* (report prepared for Center for Quality Improvement & Patient Safety Agency for Healthcare Research & Quality). Washington, DC, American Institute for Research, 2003.
3. Diehl A: Does CRM Really Work? in Kern T: *Culture, Environment, & CRM.* New York, McGraw-Hill, pp 33–51, 2001.
4. Edmondson A, Bohmer R, Pisan G: Speeding up team learning. **Harvard Business Review** October, 2001.
5. Fox News: Kentucky Plane Crash Kills 49; Crew Member Is Only Survivor. http://www.foxnews.com/story/0,2933,210650,00.html (last accessed January 13, 2007).
6. Ginnett RC: First encounters of the close kind: The formation process of airline flight crews. New Haven, Yale University, 1987 (dissertation).
7. Grubb G, Morey JC, Simon R: Sustaining and advancing performance improvements achieved by crew resource management training, in: *Proceedings of the Eleventh International Symposium on Aviation Psychology.* Columbus, The Ohio State University, 2001.
8. Helmreich RL: Human factors aspects of the Air Ontario crash at Dryden, Ontario: Analysis and recommendations, in Moshansky VP (Commissioner): *Commission of Inquiry into the Air Ontario Accident at Dryden, Ontario: Final report. Technical appendices.* Toronto, Ontario, Minister of Supply and Services, Canada, pp 319–348, 1992.
9. Helmreich RL, Foushee HC, "Why crew resource management? Empirical and theoretical bases of human factors training in aviation," in Wiener EL, Kanki BG, Helmreich RL (eds): *Cockpit Resource Management*. San Diego, Academic Press, pp 3–43, 1993.
10. Helmreich RL, Wilhelm JA: System safety and threat and error management: The line operations safety audit (LOSA). Presented at the 11th International Symposium on Aviation Psychology. Columbus, The Ohio State University, pp. 1–6, 2001.

11. Jensen RS: Crew resource management, in: *Pilot Judgment and Crew Resource Management.* Aldershot, UK, Ashgate, pp 115–149, 1995.
12. Kanki BG, Palmer MT: Communication and crew resource management, in Wiener EL, Kanki BG, Helmreich RL (eds): *Cockpit Resource Management*. San Diego, Academic Press, pp 99–136, 1993.
13. Kohn LT, Corrigan JM, Donaldson MS (eds): *To Err Is Human: Building a Safer Health System*. Washington, DC, National Academy Press, 2000.
14. National Transportation Safety Board: *Aircraft Accident Report NO. AAR-79–7*. Washington, DC, NTSB Bureau of Accident Investigation, 1979.
15. National Transportation Safety Board: *U.S. Air Carrier Operations, Calendar Year 2001. Annual Review of Aircraft Accident Data NTSB/ ARC-04/01*. Washington, DC, NTSB Bureau of Accident Investigation, 2006.
16. National Transportation Safety Board: *Aircraft Accident Report—United Airlines Flight 232, McDonnell Douglas DC-l0–l0, Sioux Gateway Airport, Sioux City, Iowa, July 19, 1989, Report NO. NTSB/AAR-90106*. Washington, DC, NTSB Bureau of Accident Investigation, 1990.
17. National Transportation Safety Board: *Safety Study: A Review of Flight crew-Involved Major Accidents of US Air Carriers, 1978 through 1990, report NO. NTSB.* Washington, DC, NTSB Bureau of Accident Investigation, 1994.
18. Musson DM, Helmreich RL: *Team Training and Resource Management in Healthcare: Current Issues and Future Directions*. Harvard Health Policy Review, vol 5, pp 25–35, 2004.
19. Pronovost P, Berenholtz S, Dorman T, Lipsett PA, Simmonds T, Haraden C: Improving communication in the ICU using daily goals. **J Crit Care** 18:71–75, 2003.
20. Reason J: *Human Error*. Cambridge, Cambridge University Press, 1990.
21. Stone RB, Babcock GL: Airline pilot's perspective, in Wiener EL, Nagel DC (eds): *Human Factors in Aviation*. San Diego, Academic Press, pp 529–560, 1998.
22. Uhlig PN, Brown J, Nason AK, Camelio A, Kendall E: M. Eisenberg patient safety awards. System innovation: Concord Hospital. **Jt Comm J Qual Improv** 12:666–672, 2002.
23. Wachter RM, Shojania KG: A culture of safety, in: *Internal Bleeding: The Truth Behind America's Terrifying Epidemic of Medical Mistakes.* New York, Rugged Land, pp 347–353, 2004.

