



## CAPS Lecture

## Parallels in safety between aviation and healthcare

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## ABSTRACT

Aviation and healthcare are complex industries and share many similarities: the cockpit and the operating theater, the captain and the surgeon. While North American commercial aviation currently enjoys a tremendous safety record, it was not always this way. A spike of accidents in 1973 caused 3214 aviation-related fatalities. Over the past 20 years, the rate of fatal accidents per million flights fell by a factor of five, while air traffic increased by more than 86%. There have been no fatalities on a U.S. carrier for over 12 years. Last year, there were 251,454 deaths in the United States owing to medical error. Pilots pioneered ways to address risks through crew resource management (CRM), and threat and error management (TEM). Both strategies, which are aimed at minimizing risk and optimizing safety, are applicable to surgery and the healthcare industry. These strategies as well as the Swiss Cheese Model, Checklists and the Normalization of Deviance will be reviewed in this article.

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The cockpit and the operating theater, the captain, and the surgeon share many similarities. This article will provide an overview of the airline industry, crew resource management, threat and error management, checklist protocol (and adherence), and the normalization of deviation — all of which translate to surgery and the healthcare industry in general. Like healthcare, aviation is a very complex industry. There are 1400 airlines operating at almost 4000 airports to every country in the world. Obviously, there are significant challenges in arriving at common solutions. *On a typical day at United Airlines*, we fly 749 large and jumbo jets with 285,000 passengers with four million pounds of cargo to 371 airports across 59 countries.

While we currently enjoy a tremendous safety record, it was not always this way. In 1957, the U.S. government took notice when a United Airlines DC7 collided with a TWA Super Constellation. They were both flying low over the Grand Canyon giving their passengers “a

close-up view”. This resulted in 128 deaths and prompted congressional hearings into airspace and air traffic control management amid much fanfare. Very little was resolved, unfortunately. A spike of accidents in 1973 caused 3214 aviation-related fatalities—*that is almost nine people a day*.

Aviation had to change—and it did. Over the past 20 years, the rate of fatal accidents per million flights fell by a *factor of five*. The rate of hull losses, which is the total loss of an aircraft, declined by a *factor of three*. Over that same period, air traffic increased by more than 86%. Air traffic is now doubling every 15 years and manufacturers are planning to deliver more than 2000 new aircraft per year by 2019. Obviously, there is no room for complacency. We believe we must be ambitious and inject even more vigor into our industry's long tradition of improvement. We need to challenge ourselves to drive the accident rates even lower than ever before.

There have been no fatalities on U.S. commercial air carriers since February of 2009 (the Colgan Air accident). The U.S. airline industry has flown five billion passengers since that event—equivalent to two thirds of the population of the world. The last fatal hull loss at United

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Airlines, absent 9/11, was in March of 1991 in Colorado Springs where a 737 encountered windshear. That was 26 years ago. Last year alone, United Airlines flew 110 million passengers.

Yet, in 2016, 2200 people died in railway accidents; 33,000 died in automobile accidents; and according to Johns Hopkins, last year in the United States, 251,454 patients died owing to medical error (Fig. 1). On the Sick Kids Caring Safely website, in Canada, 3%–4% of children admitted to the hospital suffer significant preventable harm.

### 1. Crew resource management

In aviation, the primary goal of crew resource management (CRM) is enhanced situational awareness, leadership, decision making, adaptability, event and mission analysis, and communication. Specifically, CRM aims to foster a climate or culture where authority may be respectfully questioned. Obviously, this is a delicate subject for many organizations, especially ones with traditional hierarchies. So, appropriate communication techniques must be taught to supervisors and their subordinates such that the supervisors understand that the questioning of authority need not be threatening and the subordinates understand the correct way to question orders. Keep in mind, accountability and authority are not delegated. The captain (or the surgeon) still owns that.

In history, there were two United flights that both ended in crashes. One was called a CRM success. On December 28, 1978, United flight 173, a DC8, departed Denver with 189 people on board. As they lowered the landing gear for approach into Portland Airport, the crew felt an abnormal vibration and the lack of an indicator light signaling that all three landing gear were down and locked. The crew requested a holding

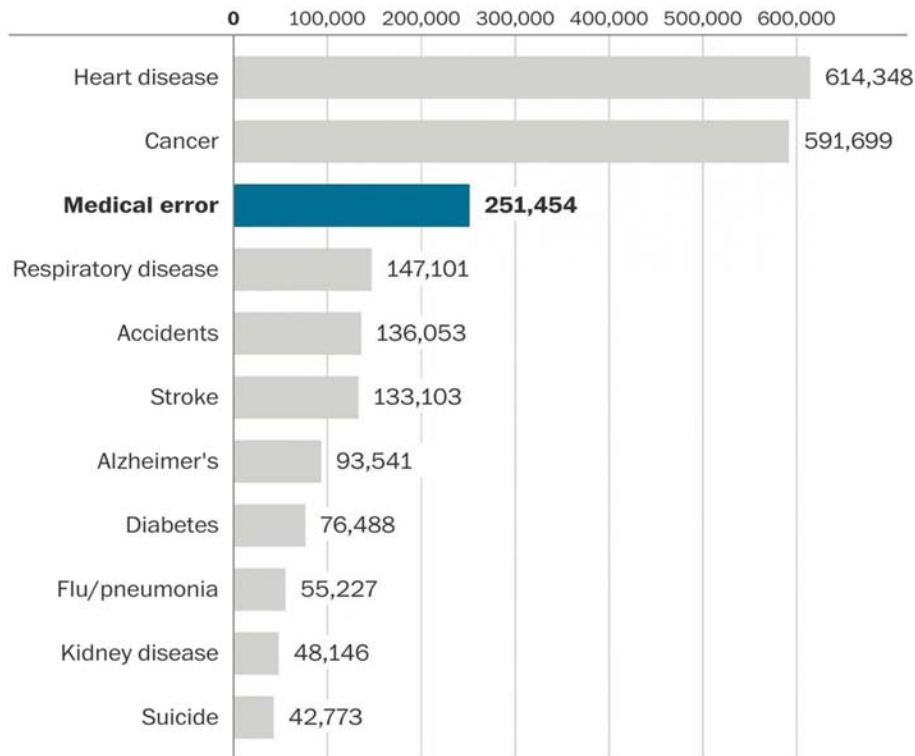
pattern to diagnose the problem. For approximately the next hour, with the landing gear and flaps extended which dramatically increased the rate of fuel burn, they attempted to diagnose the problem. During this time, both the copilot and flight engineer repeatedly noted to the captain about the rapidly dwindling fuel supply.

To set the stage, the captain had been with United for 27 years and was the airline's most senior pilot. The captain became obsessed with the circumstances and had tunnel vision. He summarily dismissed both pilots' concern. As the crew prepared for a final approach for an emergency landing into Portland, all four engines flamed out. That was the last radio transmission from flight 173. The plane crashed into a wooded section of a populated area in suburban Portland six miles from the airport, crushing two unoccupied homes. There was no fire in the wreckage because there was no fuel. Two crew members were killed, the flight engineer and a flight attendant. Additionally, eight passengers died and 21 had serious injuries. Based on the outcome of the investigation, major airlines all over the world began to change the way crews were trained. United led the industry as cockpit leadership resource management was invented. Later this was renamed CRM. This was certainly a watershed event.

The second event occurred on July 19, 1989. It was a United Airlines DC10 en route from Denver to Chicago. They were cruising at 37,000 ft. In the cockpit there were a captain, a first officer and a flight engineer. In the cabin were eight flight attendants. The DC10 has three hydraulic systems with lines running in parallel leading through the tail section of the aircraft. When the tail-mounted engine blew up, it severed all three hydraulic lines. The flight controls were no longer responding. They lost the capability to turn and to climb. They could not maintain

### Death in the United States

Johns Hopkins University researchers estimate that medical error is now the third leading cause of death. Here's a ranking by yearly deaths.



Source: National Center for Health Statistics, BMJ

THE WASHINGTON POST

**Fig. 1.** Annual loss of life in the United States. Analysis by Johns Hopkins University School of Medicine presented in the British Journal of Medicine in 2016 and reported in the Washington Post. According to the research, there were 0 fatalities on commercial air carriers; 2200 died in railways accidents (traffic crossings)—the equivalent of 5 wide-body aircraft accidents; 33,000 died in automobile accidents (up from 31,000 owing to texting); and 251,454 patients died owing to medical error (many say it's closer to 400,000).

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