Airplanes and humans are surprisingly similar: both are complex systems, both inevitably break-down, and both require precise, high-quality repair. While aircraft maintenance has been subject to stringent safety and quality guidelines, healthcare—the repair and maintenance of the human body—has not: “It is striking how little effort has been made to prevent errors in medicine, as compared with the aviation industry, in which concern about safety is paramount and work hours are carefully regulated” (1). Indeed, many physicians and policymakers agree that the frequency of medical errors, often resulting from poor information exchange, is a significant problem in our current health care infrastructure. Corroborating this concern, the groundbreaking RAND study, which recently highlighted our current health care deficit, notes that “we have little systematic information about the extent to which standard processes involved in health care—a key element of quality—are delivered in the United States” (2). It is the intention of this paper to illustrate that wearable computers, which are now used to ensure quality control in the aviation industry, can minimize several systemic errors in the health care delivery system through a new information exchange protocol, which will enable ubiquitous access to pre-existing procedural and diagnostic information, regulate communication via electronic mail, enable efficient medical record transcription via voice-recognition, and enable real-time decision support via teleconferencing.

Medical Errors - A Problem

Medical errors are a significant problem in health care today. The Institute of Medicine’s 2000 report To Err Is Human caused a firestorm of publicity on the issue of medical errors, reporting that as many as “98,000 deaths occur annually in U.S. hospitals as a direct result of medical errors” (3, 4). Despite their substantial magnitude, we tend to associate medical error with an individual physician’s sporadic or careless action. According to many physicians, however, several systemic flaws associated with our health care delivery system significantly increase the risk of individual error: Drs. Kevin Volpe and David Grande asset that “errors routinely attributed to persons...are often rooted in unrecognized problems in the design of systems” (1). An inefficient information exchange protocol and inconsistent access to diagnostic information are two systemic problems that increase the likelihood of adverse events in many health systems. Since “care is administered by teams of health care professionals,” errors often stem from poor information handoff, especially when dealing with paper records or prescriptions, which are often inaccurate or illegible due to the fact that physicians are inundated with written paperwork after each procedure or appointment (1). Additionally, many physicians note that limited, inconsistent access to charts and reference information can inhibit one’s ability to make the best decision in high-stress scenarios such those experienced in the operating and emergency rooms (1).

A system that could enhance communication between members of a care team, provide decision support, provide a better way to transcribe data, and enable reliable access to relevant diagnostic information would address the aforementioned systemic problems associated with the current health care delivery system.

Information Technology – A General Approach

Information technology systems, currently employed by some health systems, allow caregivers to store, organize, and exchange clinical information in the form of the electronic medical record. Multiple studies demonstrate that electronic medical records can improve physicians’ performance and, in many instances, patient outcomes by incorporating diverse capabilities such as ‘forcing functions’ (which require doctors to directly input specific information), direct access to pharmaceutical databases, and patient allergy checks (5-8). While electronic records have an excellent information storage capability, they are still unable to address all of the aforementioned systemic health care problems.

With electronic medical records, the inputting of data by physicians is still a lengthy process, information access is not ubiquitous, and effective information exchange between caregivers is not guaranteed. According to Dr. Joe Rosen of DHMC, electronic medical records are often accessed and updated via a laptop computer that physicians carry with them over the course of the day. Moreover, access to electronic medical records (and other diagnostic information) is not conveniently available to all members of a health care team at any location within a hospital at any time.

In summary, clinical information systems are an excellent first step, but several systemic health care
delivery problems including interruptions in care, information transcription, decision support, and diagnostic data access are not addressed by the advent of electronic medical records. Dr. Gettinger of DHMC and Dr. Lawrence Hettinger, a senior Human Factors engineer at Northrup-Grumman, assert that there currently exists a need for fast, reliable access to diagnostic data in a wide variety of clinical settings, particularly in the OR. In seeking a solution that can access pre-existing electronic medical record databases and address the systemic problems associated with health care delivery, one is drawn to the mobile information exchange protocol currently used to improve quality control in the aviation industry.

The Aviation Industry – An IT Solution Model

The aviation industry has always been subject to stringent safety and quality regulations. As a result, IT strategies have been developed and implemented to standardize processes, improve quality, and limit errors. Particularly effective solutions use wearable computers to connect the “frontline” worker with information he or she needs to complete a given task. Equipped with a small computer (Figure 1) and a head-mounted display wearable computer hardware enables hands-free, mobile computing while specific software applications enhance process standardization and maintenance task efficiency. Current software implemented on wearable computers for aircraft maintenance links to a knowledge database of procedural and diagnostic information, includes effective help management capabilities, which enable teleconferencing, and ensures accountability by storing information regarding every task completed by the worker. The aviation industry’s general approach to minimizing error is applicable to health care, but several intrinsic complexities must be taken into account.

An IT Solution for Health care Based Upon the Aviation Model

IT systems that enable quality control in aircraft maintenance cannot be directly applied to health care. While aircraft maintenance can use procedural and diagnostic data such as Interactive Electronic Technical Manuals (IETMs) to characterize, at most, a few dozen different aircraft, every patient in the realm of health care represents a distinct plane. Unlike aircraft, there are no recurring human models. Furthermore, the number of technical problems associated with aircrafts can be quantified, but problems associated with people are far less concrete. Disease can have many stages, are influenced by environmental factors such as age or race, and can interact with other conditions. As a result, it is not feasible to develop standard methodologies for approaching each disease. Finally, a standardized medical record format does not currently exist, according to Dr. Andrew Gettinger, Medical Director of Information Systems at Dartmouth Hitchcock Medical Center. Admittedly, any IT solution that intends to access a medical record database must be tailored for each specific health system to account for this lack of standardization. Despite the apparent differences between health care and aviation, the information exchange paradigm used to ensure quality in the aviation industry can be implemented to reduce the impact of the aforementioned systemic errors in health care delivery system.

Wearable computer hardware with variable display capabilities (including a head mounted display) supports the creation of a “pervasive, ubiquitous environment” in which information can be accessed by a caregiver at any time, at any point within a health system via wireless network (9). According to Drs. Rosen and Gettinger, physicians would be willing to wear a head mount if it could improve one’s ability to provide care by quickly delivering valuable information and enhancing communication between caregivers. Constant access to a knowledge database could provide a physician with information at critical times. In the OR, for example, a surgeon could quickly engage the head mounted display to view diagnostic information or a patient’s medical record. While enabling constant, convenient access to critical information, a wearable system would also provide physicians with a reliable means to update a patient’s medical record and to communicate with other caregivers.

Using advanced voice recognition capability, which is currently being developed in research labs, physicians could vocally dictate notes into information databases or clinical records. While Dr. Rosen noted that voice recognition still requires proofreading, AI pioneers Doug Lenat and Eric Horvitz predict that voice recognition will improve greatly over the next twenty five years, enabling advanced applications without significant proofreading limitations (10). Advanced voice recognition will also reduce tedious paperwork and limit transcription errors that can occur when a physician writes or types notes after administering care.

With access to a computer at all times, caregivers could reliably locate and communicate with one another in real-time. Just as aircraft maintenance IT systems use teleconferencing capabilities to help workers troubleshoot frontline maintenance problems, physicians can take advantage of teleconferencing capabilities built into wearable computer software to create a more net-centric system of care giving. In a net-centric system, workload can be more evenly distributed using collaborative decision support between members of a care team. Real-time teleconferencing reduces the likelihood of error because more parties are involved in decision
making. Furthermore, electronic communication between wearable computers is much more efficient than the current system of paging. Advanced electronic communication reduces the problems associated with care interruption; current AI technologies are being developed by pioneers at MIT that can track “phone calls, e-mail, web pages…and assign each a priority based upon the users preferences” (10). Such an application would monitor a physician’s incoming communication and prevent information overload.

In summary, an IT system based upon the wearable computer is feasible because the hardware currently exists, the approach has been proven effective in other industries that demand quality control, and the pre-existing clinical information software has been well developed by numerous health care systems.

Conclusion

Considering that medical errors cause nearly 100,000 deaths per year and medical malpractice litigation is a significant problem in health care today, an IT system that could improve the quality of care delivery by minimizing some of the industry’s systemic errors should be considered, implemented, and validated by progressive health systems. The technology to implement an IT system based upon the wearable computer, which has successfully reduced errors aircraft maintenance, is available today. As wearable computer design becomes more user-friendly, high-bandwidth wireless connections become less expensive, and voice recognition software improves, the prospects for adapting wearable computers for medical uses become increasingly more viable. Mobile computing, a revolution that has begun to take hold in other industries, is the disruptive change that will effectively usher in the new era of net-centric health care delivery in the United States.

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