Mission: Control

On a quest to improve safety and efficiency, one hospital is taking a cue from NASA's Mission Control and developing a hospital operations center.

By Louis P. Halamek, M.D., FAAP

"I can't make sense of this data." From my console, I watched as team members came together in the middle of the room to discuss what they saw on their monitors and how each data stream did or did not integrate with the others. As they verbalized their thoughts and talked through the problem, others listened intently to see if there was any way that they could be of assistance.

"The clock is ticking, folks, we need an answer." After several minutes of concise and constructive discussion, the team presented its solution to the director. With a simple nod of his head indicating he agreed with the proposed solution, the team immediately relayed the solution to professionals on the front lines. Front-line personnel implemented the solution as planned, and the team managed the situation and completed the job successfully.

Does this sound like the way a hospital functions when teams encounter problems or inefficiencies? Does the right data display for the right people at the right time and facilitate collaborative, correct decisions? This is what I witnessed as I sat in the Mission Control Center (MCC) at Johnson Space Center (JSC) in Houston, thanks to a grant I received from the Center for Aviation Safety Research at St. Louis University.

Flight controllers and astronauts prepared for their next mission with a "full-up" simulation, practicing launch, ascent, achieving orbit and docking with the International Space Station. Three different teams of flight controllers and flight directors rotated through the MCC as they simulated two days of spaceflight in 10 hours, managing different phases of the simulated mission. Each problem the simulation supervisors threw at them was solved in a similar manner—safely, efficiently and effectively. Watching these teams made me think: What would happen if a hospital could achieve similar results?

Spaceflight and health care are complex, data-rich, high-risk undertakings that share many similarities. The primary mission of any spaceflight is to achieve all of the objectives—requiring a high degree of effectiveness and efficiency—and return the crew safely to earth. A hospital's mission should be to deliver patient care in the same way. Despite these similarities, health care has not yet embraced systems engineering and human factors to the same extent as the aerospace industry, where this approach has been used since the 1950s. If more health care systems incorporated these principles, they would improve quality of care and efficiency in the delivery of care.

AT A GLANCE

- Spaceflight and health care are complex, data-rich, high-risk undertakings that share many similarities.
- Using ideas from industries like aviation, nuclear power and the military, hospitals can improve safety and communication.
- A hospital-wide hub of operations could monitor multiple data streams and translate them into actionable information.

The physician's point of view

As a practicing neonatologist in a level IV neonatal intensive care unit (NICU), I manage the human and technical resources in the unit and also maintain situational awareness of what babies are likely to deliver from the labor and delivery unit. I need to know which patients in referring hospitals have diseases that will require transport to other facilities for definitive care and the bed availability at our network hospitals in the event that it's necessary to triage patients to other facilities. That's the situation in just one unit of a busy hospital. This type of resource management and situational awareness is often repeated many times for each unit of a hospital. And that doesn't begin to approach the complexity of managing the resources of an entire hospital system.

While focusing on the function of a single unit like the NICU may appear to produce a high degree of effectiveness, the reality is this approach doesn't bring the entire hospital into context. Decisions that seem sound at the unit level may be counterproductive for the hospital system as a whole. For example, maintaining full beds in a particular unit can create a ripple effect throughout the hospital, delaying the admission of new patients, slowing down patient flow, and creating a self-induced state of perpetual chaos. This reduces a hospital's ability to respond to true emergencies, such as the need to transfer a patient from an acute care to an intensive care bed due to physiologic instability.

Taking a systems engineering approach to hospital operations allows teams to think about how the various systems and subsystems within a hospital must work together in order to achieve optimal functionality. From my vantage point as a practicing physician, this is where hospitals can learn from other high-risk industries—the ability to recognize and integrate the systems and subsystems is crucial.

GLOSSARY

Learn the lingo

Looking to other industries for inspiration also means learning new terminology.

HUMAN FACTORS

An area of psychology that focuses on ergonomics, workplace safety, human error, product design, human capability and human-computer interaction. This applies principles of psychology to designing products and creating work environments that boost productivity while minimizing safety issues.

OPERATIONS CENTER

A hub where all relevant data streams pertaining to human, system and process performance are presented graphically in an accurate, real-time manner.

SITUATIONAL AWARENESS

Being aware of what is happening in order to understand how information, events and one's actions will impact goals and objectives, immediately and in the near future. One with an adept sense of situational awareness, which is a skill that can be learned, has a high degree of knowledge with respect to inputs and outputs of a system; an innate "feel" for situations, people and events due to variables the person can control. Inadequate situational awareness is a primary factor in accidents attributed to human error.

SYSTEMS ENGINEERING

An interdisciplinary field that focuses on how to design and manage complex projects over their life cycles and ensures all aspects of a project or system are considered and integrated into a whole.

A new approach

In Palo Alto, Calif., the cost of land is high and laws strictly regulate the size of the home built on that land. Because of this, homeowners strive to maximize their square footage, often by remodeling as their needs change over time. Adding an extra bathroom is a common undertaking; however gaining access to that extra bathroom may require walking through the garage. Sometimes, hospitals seem to evolve like a home remodeling project gone awry. They might implement new services and technologies without sufficient thought about how to integrate with current systems and subsystems, creating situations that ensure suboptimal performance. New physical spaces may be relatively isolated from those performing complementary functions, and the employees required to deliver care in those spaces may be taken from other areas. Avoiding this type of situation requires a new approach to hospital-wide operations.

A systems engineering approach to hospital operations requires looking to fields other than health care where this is done well, identifying the similarities and differences between health care and those fields and collaborating with those experts. Colleagues at Johnson Space Center immediately recognized the similarities between what they do in support of a space mission into space and what providers do on a daily basis in hospitals caring for patients. The model in use at JSC—an operations center coupled with sophisticated simulation capabilities—is one that lends itself quite well to hospitals.

Interested in exploring the idea of how a hospital could adopt these practices, I was referred to the professionals at Qwaltec, a Phoenix-based company that provides systems engineering, mission readiness, technical training and program management for the commercial satellite industry and the U.S. government. This collaboration has resulted in formalization of a concept for

a hospital-based adaptation of the MCC.

At MCC, multiple, accurate real-time data streams are transformed into actionable information, and employees with the knowledge and authority to do so make critical decisions without delay. Unlike JSC, however, most hospitals don't have the centralized expertise and resources present within the MCC. The concept of a hospital operations center (HOC) would help bridge this gap and create the health care version of NASA's mission control. Modeled after the same principles, the HOC will consist of two components: an operations center and a series of simulated hospital-specific environments. These components integrate seamlessly and enhance the ability to support the mission of the hospital. Here's how it will work.

COMPONENT 1:
Operations center

Just like at MCC, all relevant data streams pertaining to human, system and process performance are presented graphically in an accurate, real-time manner. Many of the technical resources necessary to make the operations center functional already exist; others would need to be developed. This represents an opportunity for professionals within health care to drive the development of products that meet their needs.

While the software and hardware necessary to acquire, filter, route and display data will be a major component of the HOC, the employees staffing each console will also be important. These highly skilled personnel will continuously monitor the influx of data, translate it into actionable information, effectively communicate the information to those with the need to know, and make high-consequence decisions in a timely and collaborative manner. Currently, there are few, if any, jobs like this in health care. It will be important to think in terms of the type of functionality that each person in the HOC will fulfill rather than attempting to shoehorn traditional positions into these new roles.

Similarly, another key element of an operations center is the set of "mission rules" that will guide daily operations during both nominal and emergency or crisis conditions. Mission rules are developed during the light of day by experts who are well-rested, able to consider all contingencies and are not operating under time constraints. Mission rules ensure consistency in operations based on objective data when it's available and sound judgment at all times. Implementing mission rules helps avoid the pitfalls of ad hoc decision-making by less experienced personnel working under real or imagined time constraints. Some mission rules could be universal, applying to all hospital systems, while others will be unit or hospital specific.

COMPONENT 2:
Simulated environments

When some people in health care hear the word "simulation" they think of medical resident and nursing student training programs for a subset of skills-based activities. And a lot of health care simulation is focused on these types of trainees. In addition, health care simulation often occurs in facilities that don't look or function like the hospitals where the people undergoing training are actively caring for patients. Unlike other industries where the risk to human life is high, health care has not embraced simulation as standard operating procedure.

At JSC, simulation facilities look and function like the actual environments where crews operate during a space mission, providing key visual, auditory, tactile and kinesthetic cues. These cues induce realistic performance in the crews undergoing the simulations, allowing them to understand their individual and collective strengths and weaknesses. The simulated exercises crews are exposed to are based on data-driven models or actual flight experiences and have true relevance to the conduct of a successful mission. Generic simulated environments and training exercises don't help a hospital achieve the highest return on its investment. However, simulation activities

can be beneficial if they support hospital operations, are conducted in hospital-specific environments and replicate the appearance and functionality of real clinical environments. These activities should be based on risk management, quality assurance and patent safety data. They are used to train and evaluate new and existing staff on a regular basis, trial new technologies and methodologies before they are introduced, solve problems as they arise in real time, and re-create near misses and adverse events for detailed analysis.

CASE STUDIES

At the center of it all

Many children's hospitals have hubs that monitor specific areas of the facility to improve efficiency and effectiveness. Here's a closer look at two examples.

TRACKING TRANSFERS

At Children's Medical Center Dallas, the team at the Access Center coordinates patient transfers to and from Children's and all referral hospitals, emergency departments, physician offices, clinics and direct admissions from home. The center also:

- Stays on the recorded line during physician transfer communications to assure the transport team is dispatched in a timely manner with the right crew and equipment
- Dispatches the appropriate transport team: helicopter, fixed wing plane or ambulance and monitors during transport
- Connects teams with medical control as necessary during the transport
- Registers patients in the EHR system prior to their arrival
- Obtains pre-authorization from payer in the case of non-emergent transfers and obtains authorization for payment after transfer is medically and administratively approved for emergent transfers
- Follows unit and bed assignment by administrative supervisors, enters information into bed management system
- Coordinates referral provider requests for consultation with a subspecialist attending
- Participates in outer core huddles three times a day

REMOTE MONITORING

The Clinical Logistics Department at Nemours Children's Hospital in Orlando, Fla., is staffed 24/7 by a licensed paramedic who remotely monitors patients. If risk factors change, the paramedic may place the patient on a higher level of remote surveillance. If a patient triggers an established protocol, the paramedic will audio and video into the room to verify the patient's safety. He or she can also call a rapid response team or code blue and is in frequent contact with the care team, communicating data changes as they occur.

Since opening the department a year ago, the hospital:

- Decreased rapid response times to seconds
- Reduced unexpected patient mortality events on the hospital's general wards to zero due to monitoring diligence
- Alerted the bedside team to medication dosage omissions, which averaged approximately 2.2 percent of scheduled administrations, just in time for each potential dose omission
- Increased answer and response rates to bedside alarms from published rates of 2 percent to 5 percent to 25 percent to 30 percent

Children's Medical Center Dallas uses the Access Center to coordinate all patient transfers.

Progress to date

Leaders at Lucile Packard Children's Hospital Stanford and Stanford University Hospital are exploring how the HOC can enhance the safety, effectiveness and efficiency of care. Teams from Qwaltec have made three site visits to Lucile Packard to familiarize themselves with the health care environment and delineate the systems and subsystems inherent in hospital operations. This team has produced a 17-page concept of operations document that provides a high-level view of the functionality an HOC could provide.

They have also created a 10-minute video that includes an overview of a the HOC and a clinical scenario illustrating how it would work. The scenario shows the HOC in action as personnel assist with the care of a patient in a remote facility and subsequently facilitate the transport of that patient to a higher level of care as her condition deteriorates.

A formal assessment using decision analysis of the return on investment of the HOC is nearing completion. The initial target for applying the principles of systems engineering has been identified. The team will be addressing patient placement (bed control) and staffing. Leaders have identified the physical space for prototyping the patient placement and staffing functionality of the HOC. They have also developed a tentative plan for creating the simulated hospital-specific environments for the re-creation and analysis of near misses and adverse events.

Leaders from Lucile Packard and Stanford hospitals are finalizing site visits to a number of operations centers in other industries, like aerospace, commercial aviation and commercial satellite. These visits will allow them to view operations centers in action and talk with the professionals working

at these centers, as well as those who designed them.

It's apparent in examining progress to date that unlike a typical construction project, the development of the HOC is an iterative process. The strategy is to start with one operational area and develop the procedures necessary to engineer the systems that support this operation. Once these procedures have been shown to be successful, they will be used as a template for incorporating the functionality of other hospital systems and subsystems into the HOC.

Beyond implementation

This initiative will accomplish a number of important tasks as Lucile Packard and Stanford hospitals work to establish the world's first comprehensive HOC. It will allow the hospitals to:

- **DEVELOP** new ways of obtaining, routing, integrating, displaying and analyzing data.
- **STREAMLINE** hospital operations by facilitating the co-location of real-time, accurate, system-wide data with professionals who are trained to translate that data into actionable information and maintain system-wide situational awareness.
- **ESTABLISH** new benchmarks for productivity and efficiency.
- **FACILITATE** the anticipation, detection, analysis and mitigation of near misses and adverse events.
- **CREATE** a higher standard for the safe delivery of patient care and the conduct of root cause analysis.
- **TRANSFORM** culture in terms of transparency, safety, efficiency and authority.
- **CREATE** multiple opportunities for collaborative research relevant to all aspects (clinical, financial and ethical of health care delivery.

By taking a this approach to hospital operations, children's hospitals will be able to replicate the functionality at the MMC and allow teams to anticipate and react to the constantly evolving health care environment.

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