By Jeffrey B. Heyman

PLANNING FOR A REMOTE ICU MONITORING SYSTEM

Intensivists are physicians specializing in the care of critically ill patients in intensive care areas of a hospital. In comparison to care managed by primary physicians and consulting specialists, intensivist-managed care has been associated with decreased mortality, decreased length of stay (LOS) in both the ICU and on general care floors that ICU patients are eventually discharged from, and increased number of ICU admissions due to decreased LOS. However, a nationwide shortage of intensivists has prevented a large proportion of hospitals and their patients from reaping the benefits of care by intensivists.

A remote ICU monitoring system is intended to leverage the short supply of intensivists by providing a means for intensivists to continually observe patients in multiple intensive care units and hospital sites from a single remote location. The remote ICU is not intended to replace local ICU staff. Rather, it is intended to provide an added layer of care, including intensivist consultation/oversight, and, often, software tools that support analysis of a patient's lab values, vital signs, trends. Whereas in-unit care of a patient typically involves a multi-disciplinary team of nurses and attending physicians, intensivists staffing the remote ICU take a more global approach to managing the patient, looking across all variables and providing consultation and recommending intervention, when necessary. In addition, to support the recent surge in hospital-based quality initiatives, remote ICU monitoring can facilitate best practices compliance, electronic data collection, and improved patient care.

What is It?

Complete remote ICU systems are available from a small selection of vendors, and features and components may vary from system to system. Nonetheless, most remote ICU installations share some common functionality. In order to incorporate remote intensivists into local ICU care, the remote ICU monitoring system delivers a rich set of patient information from the local ICU to the remote location, and provides appropriate communication channels between ICU staff and the remote location. Patient information is provided via:

- Audio/video monitoring in each patient room
- ICU-based workstations to capture clinical information (automatically or manually)
- Direct connection to the physiologic monitoring system
- Direct connection to other information systems in the hospital, such as the laboratory information system (LIS) or picture archiving and communication system (PACS).

Communication channels include two-way, in-room voice communication between local ICU staff and remote ICU staff; dedicated "hot phones" between the local ICU and remote location; and optionally, video-conferencing between local and remote ICU staff.

As suggested by its name, the remote monitoring site is typically located in an off-site location, such as in an office building.

Architectural Impact

An awareness of general requirements as you plan for construction or renovation of an ICU can avoid headaches due to not having needed resources—electrical power, data cabling or space—where you need it. In general, the architectural impact of remote ICU implementation on the hospital is fairly minimal, and specific equipment and installation requirements will often be driven by vendors of the remote ICU equipment.

Placement of remote ICU equipment in patient rooms and elsewhere in the intensive care unit requires careful consideration, and when possible, should be determined by clinical requirements rather than availability of existing utilities. Many

TIPS FOR PLANNING FOR REMOTE ICU MONITORING

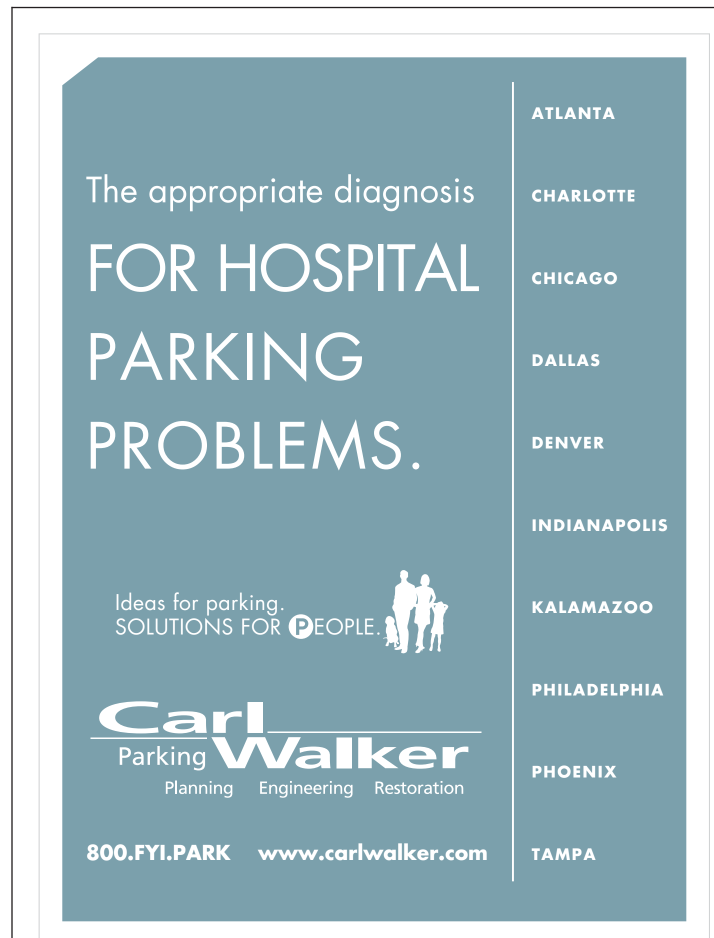
- Involve all stakeholders in planning to maximize clinical usefulness and clinical staff buy-in, including nurses, in-unit physicians, remote ICU intensivists, IT, Biomedical Engineering, etc.
- When planning placement of in-room equipment, seek out and evaluate potential "interferers" that could inhibit effective surveillance from the remote ICU or prevent effective communication between remote ICU and local ICU staff. For example, will the camera's view of bedside devices be affected by glare from outside light? Could view be obstructed by visitors, staff, or other equipment that may be brought to the bedside? Could loud equipment or other environmental factors (e.g., airflow from a ventilation duct) degrade sound transmitted via the microphone? Could the proximity of the speaker and microphone impact sound-quality (e.g., feedback)?
- Do not plan in a vacuum. Consider leveraging your investment in a remote ICU by including multiple intensive care areas, multiple hospitals within a system or even partnering with another hospital.
- Align remote ICU planning efforts with your facility's broader IT and clinical information strategies. That is, consider whether efforts to consolidate sources of clinical information facilitate or are redundant with other such efforts, such as initiatives for clinical information systems or electronic medical record.

technology-related projects are unsuccessful, not because the resulting installation is not technically and functionally sound, but because staff are not willing to make the necessary workflow changes to benefit from the new tool. Thus, the needs of clinical users should be at the forefront of planning efforts.

Patient Rooms

To allow visual surveillance from the remote ICU, each patient room requires a camera mounted on the wall or ceiling with pan and tilt capabilities. Placement of the camera should take into account the need to view the patient and bedside devices at either side of the bed, without obstructions. Common placements include high on the footwall or suspended from the ceiling near the foot of the bed.

The room must also be equipped with a microphone and speaker to allow two-way communication between the remote ICU and the patient or staff in the patient's room. The microphone is often located near the camera. Ensure that it is placed away from sources of audible alarms or in the direct path of a ventilator duct, both of which could saturate the microphone. A single speaker is preferably flush ceiling-mounted over the head of the patient, but may be wall-mounted. Placing the speaker near the head of the patient bed minimizes the volume needed for audibility to the patient and staff at the bedside. Avoid locating the speaker near the microphone to avoid feedback.



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To maximize flexibility, all rooms within each ICU should typically be made remote ICU-compatible to ensure flexibility of patient placement. Although it may be possible to implement "mobile surveillance carts" that can be wheeled into patient rooms as needed, hospitals must consider how this may ultimately impact ease of adoption. They must also provide proper storage for the carts when not in use.

Clinical Workstations

Vendors of remote ICU systems typically include a software application to collect clinical information, such as treatment logs and physician progress notes, that is manually entered by in-unit staff or automatically input by interfaced systems. The application can reside on a unit's existing workstations or on dedicated workstations purchased specifically to support the remote ICU. Requirements for new workstations will depend on the specific type of workstation selected; two common approaches are computers-on-wheels (COWs) or wall-mounted workstations. When connected wirelessly to the hospital's network and operating on battery power, COWs offer clinicians the flexibility to wheel the workstation wherever is most convenient. Wall-mounted workstations will require appropriate mounting for the display, keyboard and mouse, electrical power and a network cable.

When planning for clinical workstations, a hospital has options as to how many workstations hosting the remote ICU application are needed and where the workstations should be placed. Placing a workstation in every room maximizes accessibility for clinical staff, but also requires dedicated space in each room, potentially clogging up an already technology-heavy ICU room. Sharing mobile workstations between rooms reduces cost and the aggregate footprint of the workstations, but may be more inconvenient for clinicians to adopt into their workflow. Using workstations located in the hallways entirely removes the need for space and cabling in patient rooms, but again, may be inconvenient for staff and draws clinicians out of the room and away from the patients they're caring.

Remote ICU planning should include a careful review of options for workstation placement, with usability taking high priority. Once the decision is made, requirements for space in and out of the patient room, as well as necessary mounting and cabling should be factored into design considerations.

Nurses' Station and Other Workspaces

The nurses' station, or another centralized workspace, often houses a variety of additional equipment used to communicate with the remote ICU and to gather information to be provided to the remote ICU. Thus, the nurses' station must be designed to accommodate whichever components are desired for the chosen system.

For example, an additional workstation with the remote ICU's clinical application will commonly be placed at the nurses' station. Other components that may be required at the nurses' station include a networked laser printer and an X-ray film digitizer if a PACS is not in use or available in the remote location, in addtion to the requisite communication devices.

Physiologic monitors are typically networked into the remote ICU monitoring system such that each bedside monitor's display can be viewed at the remote location. The hardware requirements for this will vary between monitoring and remote ICU systems. Commonly, all data can be retrieved from the central station monitor located at the nurses' station. This may require an additional server at the central station to gather and transmit the physiologic monitoring data to the remote location. The server will require power, network connections to both the physiologic monitoring system and the hospital network and electrical power. If a central station monitor is not in use, cabling will be required to network the bedside monitor in each patient room and the remote ICU server.

Note: Although typically occurring in a hospital's data center (and therefore not impacting ICU design), additional cabling and other required interface hardware will be required to provide data from any other hospital information systems such LIS or PACS to the remote ICU. ■

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