A large body of research provides strong evidence that hospitals are loud environments with noise levels far exceeding those recommended by the World Health Organization (WHO). WHO guidelines specify 35 decibels (dB) for continuous background noise in patient rooms, with nighttime peaks not to exceed 40 dB. Hospital background noise exceeds those levels, and peaks frequently exceed 90 dB. Staff voices and medical equipment typically produce noise at 70–75 dB levels. Other sources of noise include alarms, bedrails, telephones, ice machines, paging systems, and pneumatic tube systems. The noise from portable x-ray machines can exceed 90 dB, analogous to walking next to a highway when a large truck passes.

Noise is good for neither patients nor health care providers. High levels of ambient noise in patient care areas have been associated with increases in blood pressure and heart rate and poor sleep patterns. Noise in nurseries has been associated with higher oxygen-support therapy needs. Hagerman et al. reported an increase in readmissions at a coronary care unit following discharge for patients who had poor room acoustics and noisy hospital stays. The emergency department (ED) can be a particularly noisy environment—and noise elevates stress in patients. Weiland et al. found that ED patients listening to a digital audio recording of nature sounds, a soothing beat, or acoustical music demonstrated less anxiety than control subjects listening to a recording of ED noise. The prospects for health care workers in terms of health and hearing loss are just as grim. Work in settings with high levels of ambient noise has been associated with hypertension and coronary artery disease. Noise-induced stress has been identified as a predictor of burnout in critical care nurses. In the ED, noise levels have been identified as stressful and interfering with communication and teaching. High noise levels in a hospital setting have been associated with hearing loss.

In the last two decades, there has been much interest in improving communication, including a substantial review of research on communication during patient handoffs in hospitals. Yet little attention has been given to the potential opportunities and challenges associated with technology-based communication, particularly with respect to its use in environments with high levels of ambient noise, such as the ED. Nevertheless, Lund et al. reported that text messaging was a “practical and feasible tool” in mass casualty events, during which background ambient noise levels are inordinately high.

In this article, we (1) review the effects of noise on patients and providers; (2) analyze the modes, mediums, and affordances of the prevalent communication mechanisms in the ED; and (3) suggest strategies to reduce ambient noise and improve communication in the ED and ways to evaluate the impact of these strategies.

Noise and Communication Breakdowns in the Emergency Department

Dugdale and colleagues have shown in computer simulations in emergency call centers that communication processes and effectiveness are affected by the distance between people, the intensity of speech, the general noise level, the level of mutual awareness, the ability to overhear, the involvement a person has with a task, and the choice of interrupting. The emergency call center is an environment with factors that negatively influence effective communication, and these factors are analogous to those identified in the ED.

The ambient noise level consistently experienced in EDs is particularly high and comparable to that experienced by rock stars who subsequently have demonstrated significant hearing loss. High noise levels have been reported to have a negative influence on patient satisfaction in the ED. Higher levels of ambient noise impede oral communication by making it difficult to discern auditory cues from background noise.

According to a 2002 Joint Commission Sentinel Event Alert, just over half of sentinel event cases of patient death or permanent injuries due to delays in treatment occur in the ED. Analyses of those cases revealed that communication errors were the number one cause of these sentinel events; 84% of
hospitals cited a breakdown in communication as a root cause for a sentinel event. These data are not surprising because work domain analyses of ED work show that clinicians spend about 80% of their time communicating. Noise, then, has the potential to reduce, prevent, and/or distort interactions in settings where communication failures are well documented. The ED is a site of critical communications delivered at a rapid pace and embedded in a chaotic environment. Eisenberg et al. identified triage, testing, handoffs, and admitting processes in ED encounters that are particularly vulnerable to communication breakdowns. Communication breakdowns related to noise in the ED may take one of the three forms characterized by Vincent and Wears—omission, ambiguity, and excessive volume:

1. Communication Omission: Physical layout, leaded walls (which interfere with wireless radio signals), interruptions and distractions, and too many work-arounds required to enter data in an electronic system are examples of conditions that can contribute to the omission of communication, such as the failure to record a new allergy, which could result in a medication error.

2. Communication Ambiguity: Communications may be undermined by semantic ambiguity (in which the sender and receiver assign different meanings to a phrase), phonetic or lexical ambiguity (as reflected in the sound-alike medications “amrinone” and “amiodarone” or the diagnoses “aortic stenosis” and “atherosclerosis”), and message ambiguity (a noisy “channel” such as an ED results in a mismatch between the message transmitted and received). Unfortunately, the natural response to noise is to speak louder, thereby further increasing the overall level of ambient noise.

3. Communication Volume: The volume of information may overwhelm short-term memory. “causing some of the information to be lost before processing is completed.” Talbot and Bleetman found that only 49%-57% of verbal content from a handoff update from emergency medical services personnel to ED staff was retained after five minutes. These findings were consistent with findings from the operating room setting, where noise levels > 77 dB were associated with anesthetists having lower short-term memory retention and mental efficiency. Unfortunately, most EDs spend little time planning for and assessing the effectiveness of the communication mediums they employ. ED clinicians and administrators should carefully plan a communication scheme using several communication mediums to fit the situational complexities of ED interactions.

Communication Modes

Each of the two most common modes of communication—verbal and written—has advantages and limitations, particularly in the ED setting. Verbal communication, whether face-to-face or via telephone or another device, is a quick and direct method for efficiently creating a shared understanding about a patient. Pitch and intensity can be varied to convey complex messages with many subtleties. In face-to-face communication, receivers can offer immediate feedback and indicate comprehension through body language and by asking questions. Verbal communication also tends to be less formal and is appropriate for conveying short-term information about what needs to be done in the immediate future. It further allows for an iterative back-and-forth conveyance of patient information and provides an opportunity for questioning between sender and receiver, a feature that has been noted in the communication strategies of high-performance organizations during handoffs.

Written communication is a critical mode in health care because it constitutes the permanent record. In an electronic format, information can be easily accessed by multiple staff members and can be widely disseminated as a broadcast message. When information contains highly technical terms or specific numeric values, written communication is much preferred because it is permanent, can be reviewed, and is less prone to misinterpretation.

A third mode of communication prevalent in the ED is visual signaling. Typically, the signal or cue is an actionable item that uses existing symbols that have been pre-identified to exclusively mean something. In a recent study, for example, a pulsing flashlight was used as a feedback device to guide medical students through cardiopulmonary resuscitation (CPR) in a noisy environment. When guided by the pulsing visual signal, the medical students, who had had no previous experience of using flashlight-guided CPR, performed effectively and were able to constantly maintain the desired rate of chest compressions, despite the high level of artificially generated background noise.

In Table 1 (page 281), these three modes of communication are used to categorize several examples of communication-support technologies, which are also grouped by whether the communication is intended for one or many receivers.

Communication Mediums

*Mediums* are the means by which information is transmitted (typically between a speaker or writer and a receiver). They can be organized according to whether or not they are based in
technology (Table 2, above). EDs vary in their technology support, and smaller EDs may have no electronic tracking system, cell telephones, or radios. We have attempted to identify all of the mechanisms available for communication in EDs, whether they have robust technological support or are still whiteboard-and paper-driven. The goal is to get ED staff thinking about the communication mediums available to them with current resources and to encourage them to create a comprehensive scheme for managing communication in the ED. It is also important for ED leaders to anticipate their departmental needs as they continue to gain in census and to consider the resources that might be necessary to optimize communication in the future.

**FACTORS INFLUENCING MEDIUM SELECTION AND USE**

A number of factors influence the optimum selection of a communication medium in the ED and influence its effectiveness. We now consider these factors and their implications.

**Census and Physical Layout Variations.** The ED’s physical environment, particularly the size and layout, greatly influences the choice of optimal communication methods. In a 15,000-visit, 10-bed, 2,500-square-foot department, simple traditional modes of communication such as face-to-face, writing on a whiteboard, and flagging the physical chart (a visual signal) may suffice. However, in a 100,000-visit, 50-bed department, a hierarchy for communication is likely required unless the ED is subdivided into smaller units, such as geographic zones that function like small EDs. Face-to-face communication gives way to wireless hands-free communication devices in mid-volume EDs, where direct communication becomes more difficult to carry out. But as volumes go up, such devices become less usable because of ambient noise and interruptions. Therefore, it is not surprising that ultra-high-volume EDs are increasingly using dedicated cellular telephones with speed dialing and text-messaging features.

Certain principles regardless of ED size likely apply.
Convenience is a threshold by which providers often decide whether or not to pursue communicating essential messages. Proximity and accessibility support frequent interaction and relational development conducive to collaboration in health teams. Physical layouts that afford clear “lines of sight” and include common workspaces facilitate good communication habits. Studies have shown that face-to-face communication is still the most common means of communicating patient care information in the ED and that the charge nurse is often the pivotal figure receiving the most communications per shift.

Stationing ancillary services (such as a radiology unit and laboratory personnel dedicated to the ED) in close proximity to the central work hub appears to promote teamwork and communication, thereby resulting in better performance on time metrics.

Departments that are fortunate enough to have a dedicated pharmacist located near the nurses’ station are more likely to receive greater medication oversight, partially because of increased informal verbal communication.

Communication Needs of Nurses and Physicians. Nurse communication is mostly local and can occur without divulging protected patient information (for example: “Julie, can you take more Zofran to Room 6 for me?” or “Dr Smith, can Bed 4 have more pain meds?”). Yet when nurses hand off a patient, such as when a nurse calls the floor to give a report about a patient, the communication exchange is usually longer; the nurse typically sits down and uses a landline telephone with the paperwork in front of him or her, with appropriate consideration of protected information; faxing reports is a possible alternative.

In contrast, physician calls are frequently made to persons outside the ED and even outside the hospital. Private health information, including the patient’s name and health data, is usually exchanged, which is why dedicated cell phones are the preferred route of communication for physicians. While nurses are comfortable with wireless hands-free communication devices, physicians often view them as disruptive to their workflow. When used by the physician, such devices can loudly disrupt the bedside encounter or important phone consultations with other physicians. At ChristianaCare (Wilmington, Delaware), where the ED has 114,000 visits a year, the nurses use these devices, which can also be used to call physicians on their (dedicated cell) phones. While Breslin, Greskovich, and Turisco reported benefits from the use of such wireless communication, Woloshynowych et al. found that the use of such devices in the course of patient care was associated with more interruptions.

**Affordances in Communication Mediums**

An **affordance**, according to Norman, is an aspect of an object’s design that provides strong clues as to how the object should be used. It “refers to the perceived and actual properties of a thing, primarily those functional properties that determine just how the thing could be used.” The term is typically applied to new technologies but can be applied to all the mediums available for communication in the ED. In a sentinel publication articulating the elements necessary for effective communication, Clark and Brennan discuss affordances in communication. Characteristics such as cœtemporality (whether participants are present at the same time, such as for the phone versus using a visual signal on a whiteboard) and simultaneity (for example, pager messages are received, but responses cannot be sent at the same time using the pager) influence the choice of communication mode selected. The ideal choice of communication mediums will depend on a host of factors. The mediums listed in Table 3 (above) are appropriate for different levels of urgency, with modification by other

<table>
<thead>
<tr>
<th>Mediums</th>
<th>Urgency</th>
<th>Privacy</th>
<th>Target</th>
<th>Length</th>
<th>Capacity for Dialogue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead page</td>
<td>High</td>
<td>–</td>
<td>+</td>
<td>Short</td>
<td>–</td>
</tr>
<tr>
<td>Face-to-face</td>
<td>High</td>
<td>+</td>
<td>+</td>
<td>Long</td>
<td>+</td>
</tr>
<tr>
<td>Phone</td>
<td>Med</td>
<td>+</td>
<td>+</td>
<td>Long</td>
<td>+</td>
</tr>
<tr>
<td>Text</td>
<td>Med</td>
<td>+</td>
<td>+</td>
<td>Short</td>
<td>–</td>
</tr>
<tr>
<td>Wireless hands-free communication device</td>
<td>Med</td>
<td>–</td>
<td>–</td>
<td>Short</td>
<td>–</td>
</tr>
<tr>
<td>Pager</td>
<td>Med</td>
<td>+</td>
<td>+</td>
<td>Short</td>
<td>–</td>
</tr>
<tr>
<td>Visual signal*</td>
<td>Low</td>
<td>–</td>
<td>–</td>
<td>Short</td>
<td>–</td>
</tr>
</tbody>
</table>

* See Table 2 for examples of visual signals.
Strategies for Improving Communication in the ED

Strategies for improving communication in the ED, as summarized as reducing ambient noise and designing a communication scheme, often need to involve architects and designers (Table 5, page 284).

Reducing Ambient Noise

Reports of efforts at reducing noise in health care settings have appeared in the literature. At one site, the ICU installed a noise-level monitor. As noise on the unit increased, the staff received a real-time signal.44 When levels were in range, the monitor showed a green light. When the sound exceeded the recommended levels, it went yellow; and when it was in a danger zone, the monitor showed red. “High-sound” contributors such as the lids on the garbage bins were very noisy, so they were replaced: A less noisy x-ray machine was purchased, and alarms and phones were programmed to a lower decibel level. At an inpatient neuroscience unit, overhead paging was reduced and staff were trained to speak more quietly.55

Single-patient rooms have been shown to be quieter than
Table 5. Strategies for Improving Communication in the Emergency Department

<table>
<thead>
<tr>
<th>Reducing Ambient Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ Use a sound meter to identify loud noise.</td>
</tr>
<tr>
<td>■ Pad trash can lids.</td>
</tr>
<tr>
<td>■ Pad tube system.</td>
</tr>
<tr>
<td>■ Limit portable x-ray machine use.</td>
</tr>
<tr>
<td>■ Replace loud paper towel dispensers.</td>
</tr>
<tr>
<td>■ Limit overhead paging.</td>
</tr>
<tr>
<td>■ Limit radio use.</td>
</tr>
<tr>
<td>■ Provide staff training to decrease speech volume.</td>
</tr>
<tr>
<td>■ Provide sound-absorbing ceiling tiles.</td>
</tr>
<tr>
<td>■ Provide sound-absorbing wall paper.</td>
</tr>
<tr>
<td>■ Decentralize work areas.</td>
</tr>
</tbody>
</table>

Designing and Articulating a Communication Scheme

■ Provide whiteboard communication.
■ Track system communication.
■ Provide text messaging.
■ Provide dedicated cell phones.
■ Limit overhead paging.
■ Limit radio use.

multiple patient rooms, which, along with the lower associated risk regarding health care–associated infections, has led to an increase in their use, even in the nursery. Another important and proven design intervention is to install high-performance sound-absorbing ceiling tiles that reduce echoing and reverberation and sharply diminish sound propagation. A key component of quieting facilities is to eliminate noise sources. Even motion-sensing paper towel dispensers have been shown to increase the decibel level in a clinical unit. Every design change must be considered in terms of its contribution to the noise level. Insulating ice machines and pneumatic tube systems can significantly decrease noise levels in the ED. Noise-reducing panels and wallpaper, strategically placed, significantly reduced noise in an oncology ward at Johns Hopkins Hospital.

Decentralizing workstations on nursing units has also been shown to reduce noise in inpatient settings. EDs with large numbers of rooms operating out of a central hub are particularly noisy.

**Designing and Articulating a Communication Scheme**

By crafting a deliberate scheme with a hierarchy for communications and understanding the affordances of each medium, EDs can improve communication and decrease noise. This can be done in both technology-driven and technology-independent departments alike. In particular, an emphasis on decreasing overhead paging in the department would be a big step on the road to improved communication. High overall noise levels are a detriment to patient and staff well-being and an impediment to effective communication. By carefully selecting and articulating the mediums to be used in the ED, organizations can improve the overall efficacy of communication. Through deliberate methods, the noise level of a department can be decreased and the communication model improved. By deliberately identifying levels of urgency or emergency in communication content, and then implementing an appropriate communication method, a communication scheme can be designed that is appropriate for a particular department.

The potential for information technology to improve communication in the ED is just beginning to be realized. A homegrown consultation management system that automatically sends out consulting pages and tracks responses decreased the length of stay for ED patients at a hospital in South Korea. At the ED at Mt. Sinai School of Medicine (New York City), following implementation of a fully integrated information system that was designed to facilitate clinical work flow with computerized provider order entry, improvements were reported for length of stay, door-to-physician time, and imaging and laboratory turnaround times. These two examples are likely the beginning of a trend in which care processes, information technology, and architectural design combine to bring about improved communication, operational efficiencies, and an improved quality of work environment.

However, technology alone will not improve communication in clinical settings. For example, Quan et al. recently reported that the implementation of a new Web-based communication system increased interruptions of clinical providers by 233%. The authors stated, "failing to account for the sociotechnical aspects of HIT [health information technology] or the interplay of technology with existing clinical workflow, culture, and social interactions may create other unintended consequences." The TeamSTEPPS program and similar initiatives designed to improve teamwork and communication are being applied in various health care settings, including the ED. We suggest that there are environmental and technological aspects to improving communication in clinical settings with high-intensity work, like the ED, and that these need to be managed as well. Clearly, there is room for improvement in the ED beyond the addition of new technologies.

When the University of Kentucky rebuilt its ED, close attention was paid to noise and communication. This ED, which had more than 50 providers, including residents, on duty at a time, had struggled with high levels of ambient noise.
and interruptions. The new department, which was completed in 2011, was designed into smaller pods, which, like decentralized nursing stations, as stated, reduce noise and improve communication. ED staff were told that there would be no overhead paging system and that they had to craft communication strategies using other modalities. The frontline workers devised a tiered communication system that included a mixture of face-to-face communication, wireless hands-free communication devices, status boards, and dedicated cell phones. They heavily relied on their computer system for non-emergency communication. The department installed 240 computers with ID badge smart readers for easy log-on. After several months, they were allowed to use overhead paging for emergencies, but the new system was well established. Staff reported that the stress level decreased with the decibel level, even on busy shifts, providing a more calm environment for patients and families.36

Conclusion

It is possible in the future that we will identify the gold standard for communication in EDs, including the best communication schemes and the best communication mediums by volume. The best results will be seen when process improvement, technology, and environmental design come together in this work. The sophisticated ED will use multiple modes of communication purposely chosen to meet the needs of its unique environment. As the field moves forward, the following understandings relative to ED communication strategies are critical:

- The noise level in most EDs is too high and is bad for patients and staff and has important patient safety implications.
- The respective communication needs of nurses, physicians, and staff may be different.
- There are affordances in each ED communication medium that can be factored into the optimal selection for a particular message.
- The need to limit interruptions and decrease the overall noise level in the ED while improving overall communication strategies should be a prime goal for our specialty.
- A method of assessing the effectiveness of any communications scheme should be employed as improvement efforts are initiated.
- There are design elements involving layout and building materials that can improve the efficacy of communication and reduce noise.
- Improving communication in the ED will require a multidisciplinary effort involving operations and processes, information, and other technology and environmental design.7

References


