Cause for alarm?

Patient monitoring and medical device alarms in the intensive care unit

BEN FINEMAN

Intensive care units are full of sophisticated patient monitoring technology. Most monitoring devices have several alarms, intended to alert ICU staff to problems. While alarms are undoubtedly useful, there are a high number of false and clinically irrelevant alarms, leading nurses to ignore or disable them. In addition, true alarms often convey ambiguous and inconsistent information, poorly integrated into nursing workflows.

To address these problems, I will design a device that assists in patient monitoring by giving nurses important information in a more meaningful, more efficient, and less disruptive manner.

Research

- Medical journal literature review
- Device literature, nursing manuals
- Observations in ICUs
- Interviews: ICU directors, nurses, respiratory therapists
- Expert consultant: former ICU nurse

	Research questions	Examples of detailed findings	Resulting artifacts
activities	• How do nurses respond to alarms? • What information do they use to make decisions? • What other routine tasks do nurses perform?	• Alarms are less significant during patient intervention • The patient is often a better source of information than numbers or alarms • Nurses need trend information and context to interpret numbers	• Task list • Alarm response model
environments	• How does the space of the ICU affect monitoring? • What is the level of noise, light, traffic, and activity? • What are the differences between types of ICUs?	• Information is spread out in many different locations • It's difficult to locate the source of some alarms • With the curtain closed, it's difficult to tell if there's a nurse in a room	• ICU environment observation notes • Space sketches
interactions	• How do nurses interact with other people? • How do nurses interact with devices and technology? • When are alarms disabled or silenced?	• Tacit knowledge is exchanged verbally, including advice, stories, and opinions • Nurses don't use all of the features of the technology • Nurses play a significant role in managing visitors	• Relationship diagram
objects	• What are the devices present in the ICU? • What alarms do they have? For what problems? • Who sets and modifies alarm limits?	• Only the newest systems integrate many devices • There are about 70 different alarms associated with monitoring patient status • Any alarm could point to serious problems, but some predict better than others	• Device list • Alarm taxonomy • Display library
users	• Who are the people in an ICU? • Why are they there? What are they doing?**Example**	• Respiratory technicians may assist with ventilator alarms • Patients have many people associated with them, including assistants, doctors, respiratory therapists, dialysis technicians, social workers, visitors, and priests	• Role / task list • Relationship diagram

Insights

- Nurses should spend their time worrying about patients, not how to deal with alarms
- The space of the ICU is underutilized as a means of both input and output by monitoring systems
- Alarms are poor indicators of patient health
- In making decisions, nurses rely on examining the patient, talking to other people, patient stories and history, and their own knowledge and experience in addition to the information given by the alarm

Design implications

Awareness
Monitoring systems could be aware of
- Who is in the room
- Who is closest to the patient
- Where all the people associated with the patient are
- Which devices are in use
- Which procedure is being performed on the patient
- The alarm status of other patients

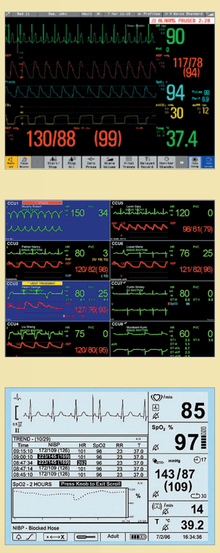
Display
An improved information display could
- Integrate patient health data values with trends and alarm limits
- Better use the space of the ICU
- Integrate information about the patient's condition, devices, and the patient's body
- Target alarms to specific people, with an appropriate level of intrusiveness
- Be less taxing on nurses' limited attentions

Consolidation
Information and alarms from multiple devices could be consolidated in one location

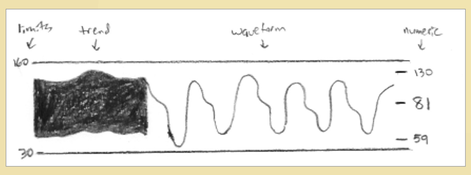
Communication
Monitoring systems could facilitate communication with the various people associated with patients

Agency
Monitoring devices function like agents, and could benefit from new research and technology in the field

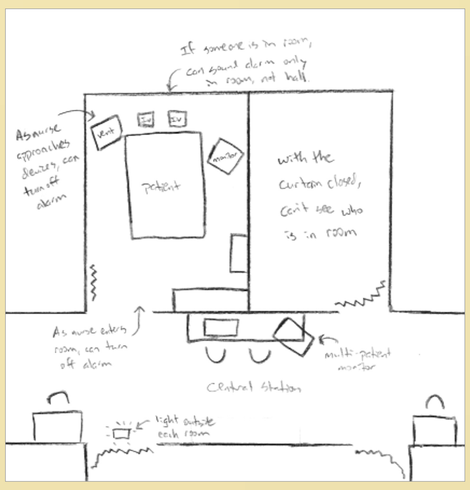
Practicality
- Due to the mix of technology, the new system should be modular, working with a range of other devices
- Because of HIPAA regulations, the system must protect patient health information
- A hands-free design in the patient room, because of gloves and bodily fluids on hands



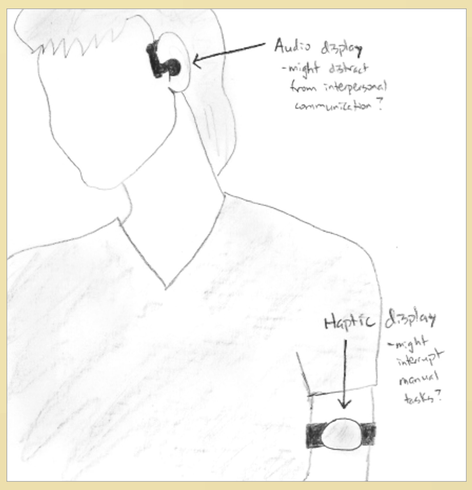
Typical patient monitoring system displays. Alarm limits and trends are usually on a separate screen.



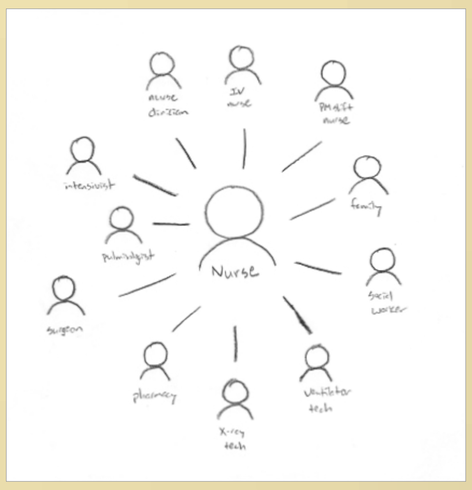
A revised display could integrate numerics, waveform, trends and alarm limits into one graphic.



Awareness of where nurses are within the ICU space could be used to determine their likely activity and better target alarms.



A wearable alarm indicator could reduce ICU noise and confusion by targeting alarms only to those who need to hear them.



A communication device could quickly put nurses in contact with any of the people associated with a particular patient.

Timeline and next steps