**////Title: Musical Alarms: Improving Medical Environments by Studying Sound**

**////Bodytext:**

Medical devices in hospitals use auditory interfaces to keep doctors and nurses updated while keeping their eyes focused on patients. These auditory alarms are crucial for complex procedures, such as placing a breathing tube. Unfortunately, the specific sounds used in current systems are highly problematic. The lack of sophistication in these tones render them annoying and distracting, harming communication amongst medical staff and posing risks for patient care. An FDA survey has revealed hundreds of deaths annually resulting from poorly designed alarms! Although there are many ways to improve their use, one solution has received little attention thus far – improving the quality of the sounds themselves.

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Dr Michael Schutz from McMaster University is applying his insights as a psychologist and a musician to improve the quality of the auditory signals used in the life-saving devices filling hospitals around the world.

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In 2007, Dr Schutz demonstrated that visual information changes how we ‘hear’ music. He documented that the complex nature of musical sounds – which contrast markedly with the simplistic tone beeps commonly used in auditory research – was the cause of this phenomenon.

Sounds can be described through their ‘shape’ over time. Most natural sounds, including musical sounds, have complex temporal shapes. For example, percussive sounds caused by impacts start quickly and begin decaying immediately. We typically find these dynamic sounds pleasing, and they are used frequently in music. In contrast, machine-produced beeps use markedly different shapes, including rapid offsets. This makes them very different from sounds heard in everyday listening.

A sound’s complexity plays a crucial role for timbre. Timbre is what makes instruments sound different from one another, even when playing the same melody. Consider the individual components of both complex music sounds and standard machine beeps.

This type of 3-D representation illustrates each component, or harmonic, on the horizontal (x) axis. Additionally, it shows the way each component’s energy (vertical, y-axis) changes over time (z-axis). In musical instruments such as the violin, the strength of individual components varies continually over time, with each component moving somewhat independently. Yet in many medical devices the components are relatively constant, and typically start and stop at the same time.

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Many alarms follow the global medical standard set by the International Electrotechnical Commission, where sequences are made with three or five notes, all of which are based on standard beeps. Their simplistic shape requires them to be very short to avoid overlap.

What might happen if each individual tone used a complex shape instead? Could this more complex approach allow for the blending of notes into a sequence more similar to how music is structured? Dr Schutz’s team collaborated with Dr Joseph Schlesinger of Vanderbilt University Medical Center to address this question.

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Participants heard an alarm along with its indicated issue (e.g., temperature problems). They then responded to the alarm’s function when hearing it again, receiving feedback on their response. After a break to distract, they heard the alarm and again reported its function.

Analysis of the responses indicated that the type of sound used doesn’t affect participant recognition or learning, but it does have one crucial impact – the new approach using percussive tones is resoundingly less annoying.

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These findings hold exciting promise for real-world application. Dr Schutz has shown that alarms based on percussive sounds are just as effective at communicating as standard beeps. However, they are less annoying and can provide a positive adjustment to the environments of those being treated, recovering and working in medical facilities.

As hospitals all over the world use these devices daily for critical monitoring of patient health, even small improvements in their design can be leveraged into meaningful improvements in public health. Dr Schutz continues his work with his network of collaborators to improve the sonic landscape of hospitals.