

# Testing auditory alarm effectiveness with three different alarm sets



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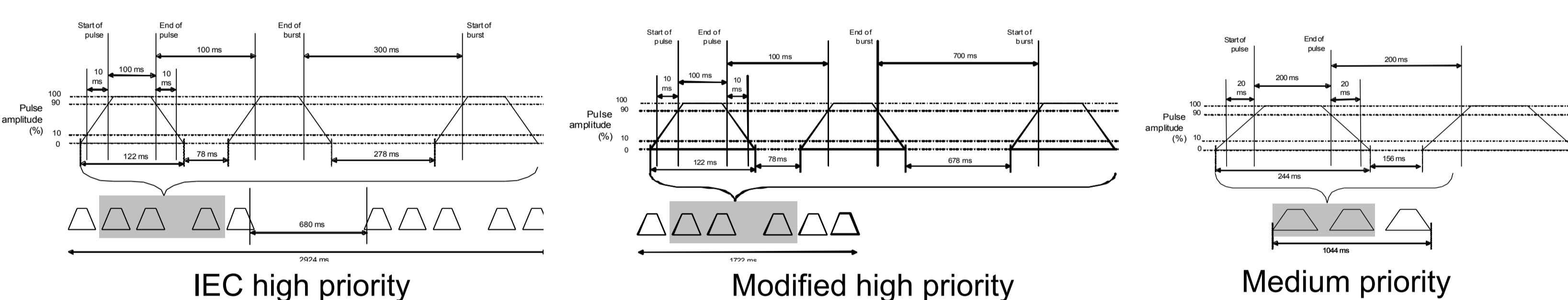
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The melodic auditory alarms described in the IEC 60601-1-8 standard for medical electrical equipment can be difficult for healthcare personnel to learn and identify. We tested some alternative alarm sets to see whether they would be easier to learn and identify.

## Method

We compared anaesthetists' ability to learn six alarm sounds, each in medium and high priority forms, from three different alarm sets:

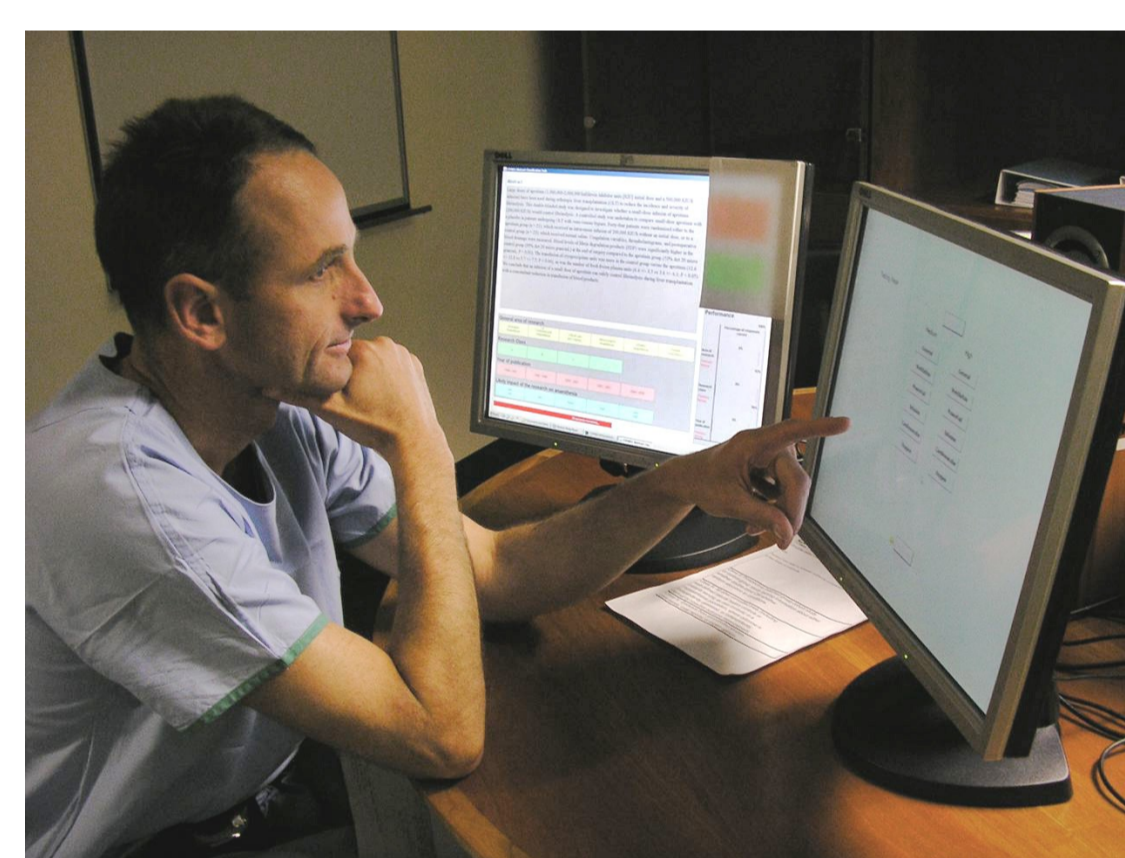
- The set proposed in the IEC 60601-1-8 standard for alarms on medical electrical equipment (IEC)
- A modification of the IEC set (Modified) with simplified high priority alarms
- A set of highly mutually differentiated sounds developed over 20 years ago by psychoacoustician Roy Patterson (Patterson).



Anaesthetists (n=44) were randomly assigned to learn either the IEC, Modified, or Patterson alarm sets.

Across two separate learning sessions, anaesthetists identified alarms:

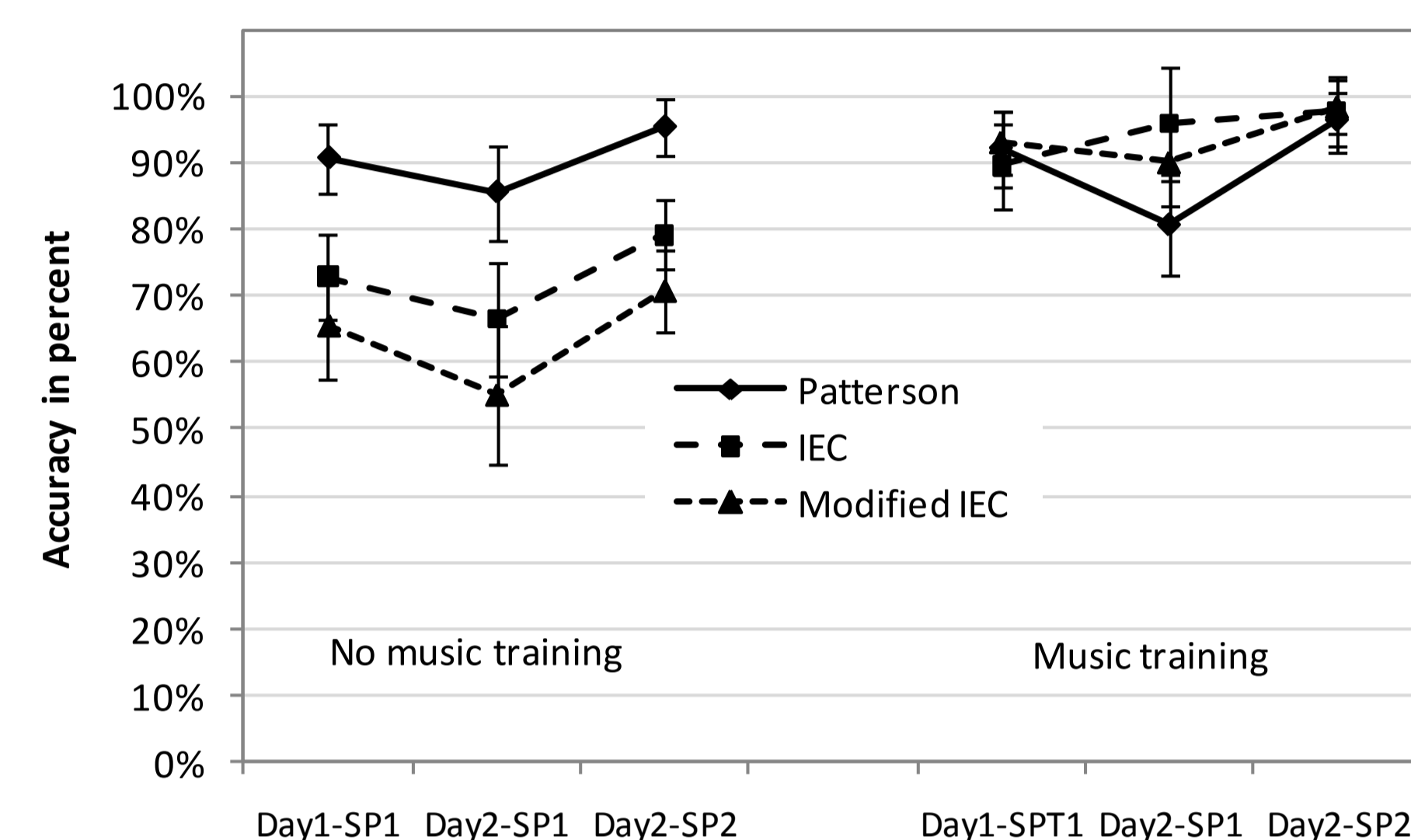
- When played when requested, with no background distractions
- When played at random intervals, while they performed a distractor task and heard background music.



Participant identifies alarm on right hand screen. Distractor task (a reading and classification task) is on left screen.

## Results

By the end of the experiment, the percentage of anesthesiologists identifying alarms with accuracy of 90% or more was 86% with no distraction, and 63% when distracted. Anaesthetists with music training performed much better than those without ( $p < 0.001$ ). Perceived urgency was greater for high vs. medium priority alarms in all alarm sets. Confusions between priority levels were minimal.



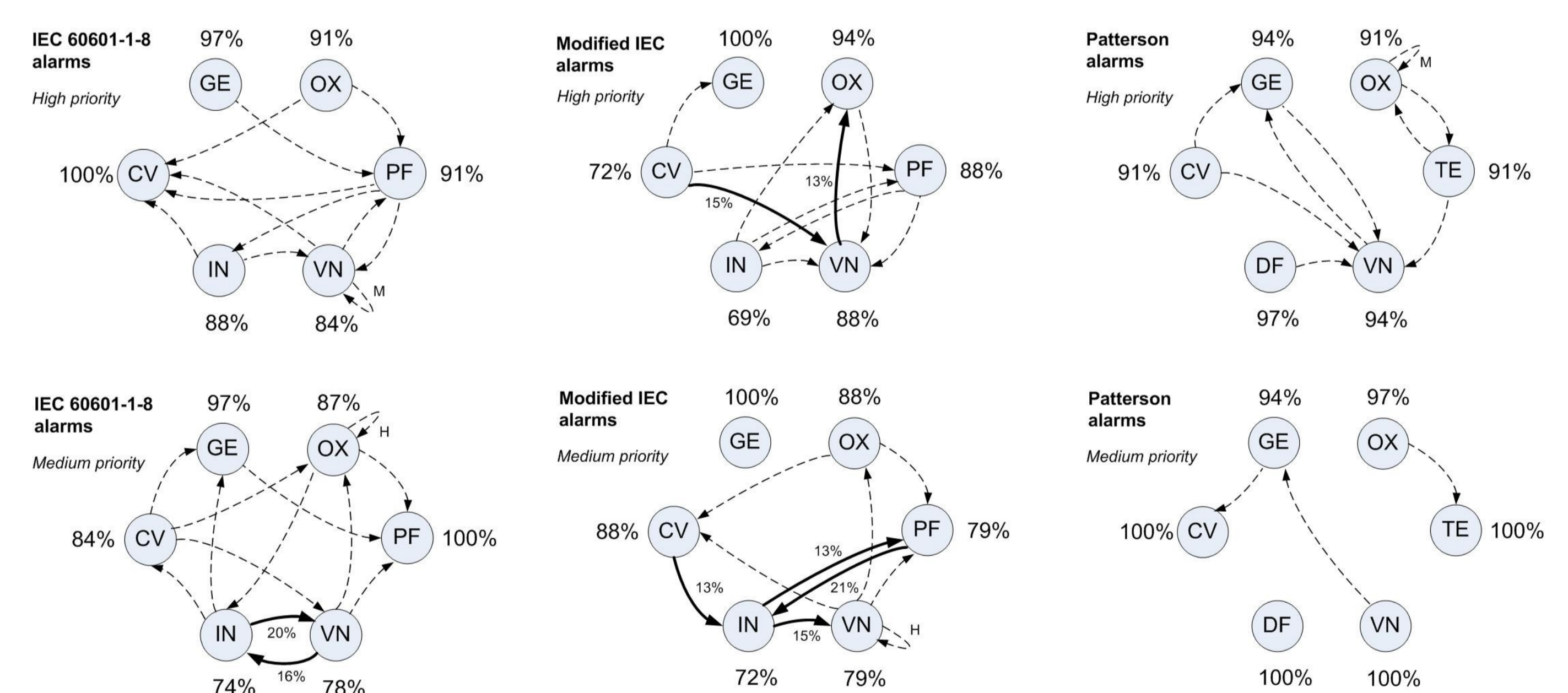
Anaesthetists with music training performed equally well with all three alarm sets.

Anaesthetists without music training performed best with the Patterson alarm set but less well with the other alarm sets.

Learning time, accuracy and response time did not differ significantly across the three alarm sets.

However, when not distracted, anaesthetists without music training identified the Patterson alarms as accurately as those with music training (without=91%, with=90%), but this was not the case for the IEC set (without=74%, with=94%) or the Modified set (without=64%, with=94%) ( $p < 0.05$ ). A similar but weaker trend was noted when participants were distracted.

Although response time was slower for high compared to medium priority forms of the IEC alarms ( $p < 0.001$ ), the Modified or Patterson alarms did not support faster response times than IEC alarms.



Anaesthetists confused some alarms with others. These diagrams show that the actual alarm at the start of an arrow was falsely identified with the label at the end of the arrow.

Participants who experienced the Patterson alarm set showed far fewer confusions overall than did participants experiencing the other alarm sets

## Conclusions

The anaesthetists could learn to identify six different alarm sounds, each in two priority levels. High priority Modified alarm sounds could be announced in a shorter period of time than the standard IEC high priority sounds, without adversely affecting performance.

Compared to musically trained anaesthetists, anaesthetists without prior musical training performed worse on IEC-type (melodic) alarms but equally well with Patterson alarm sounds. Overall, the Patterson alarms performed as well as or better than standard IEC sounds.

Further development of auditory alarm signals should be supported by testing with representative users at key points during development.