The Sound Intensity and Characteristics of Variable-Pitch Pulse Oximeters.
Yamanaka H., Haruna J., Mashimo T., Akita T., Kinouchi K. *J Clin Monit Comput*. 2008 Jun;22(3):199-207.

Objective
Various studies worldwide have found that sound levels in hospitals significantly exceed the World Health Organization (WHO) guidelines, and that this noise is associated with audible signals from various medical devices. The pulse oximeter is now widely used in health care; however the health effects associated with the noise from this equipment remain largely unclarified. Here, we analyzed the sounds of variable-pitch pulse oximeters, and discussed the possible associated risk of sleep disturbance, annoyance, and hearing loss.

Methods
The Nellcor N 595 and Masimo SET Radical pulse oximeters were measured for equivalent continuous A-weighted sound pressure levels (L(Aeq)), loudness levels, and loudness. Pulse beep pitches were also identified using Fast Fourier Transform (FFT) analysis and compared with musical pitches as controls.

Results
Almost all alarm sounds and pulse beeps from the instruments tested exceeded 30 dBA, a level that may induce sleep disturbance and annoyance. Several alarm sounds emitted by the pulse oximeters exceeded 70 dBA, which is known to induce hearing loss. The loudness of the alarm sound of each pulse oximeter did not change in proportion to the sound volume level. The pitch of each pulse beep did not correspond to musical pitch levels.

Conclusions
The results indicate that sounds from pulse oximeters pose a potential risk of not only sleep disturbance and annoyance but also hearing loss, and that these sounds are unnatural for human auditory perception.