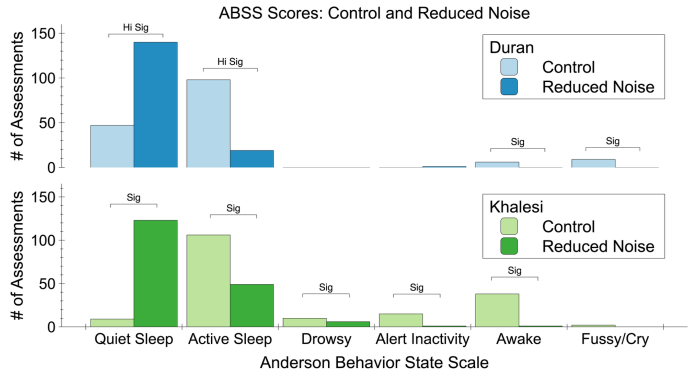
Incubator-based Active Noise Control System: Quantifying Size Of Attenuation Zone And Comparison To Earmuffs

George Hutchinson, PhD

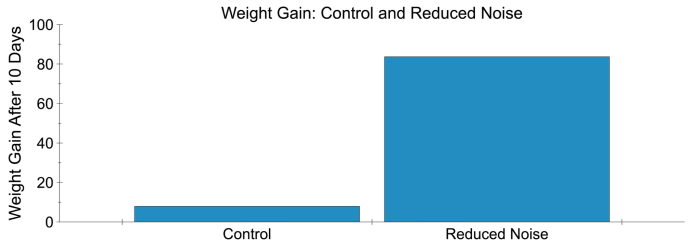
Background

The aural stimulation of the hospitalized infant in the neonatal intensive care unit (NICU) from alarms, ventilators, phones, conversations, and air handling system is linked to negative effects on sleep hygiene, weight gain, sensitivity to pain, and vital signs in the short term and in the long term with neural development. Quieter environments have shown improvement in the ratio of quiet to active sleep and weight gain, even over a short study period.

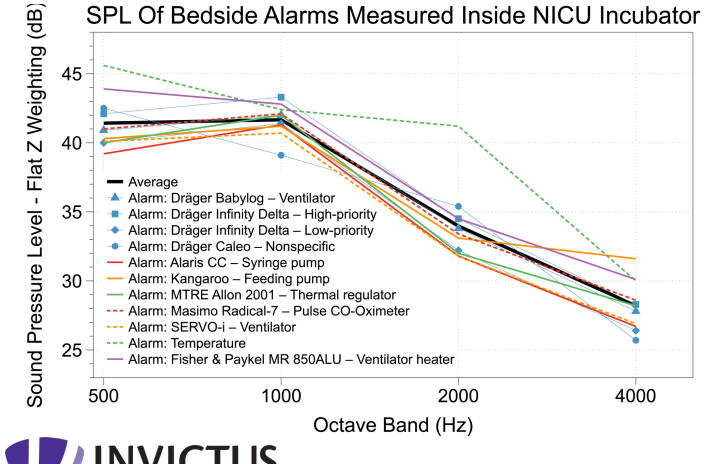
Quieter environment can lead to better NICU sleep hygiene



Quieter environment can lead to better NICU weight gain



NICU noise is most prevalent in 500 Hz and 1 kHz octave bands



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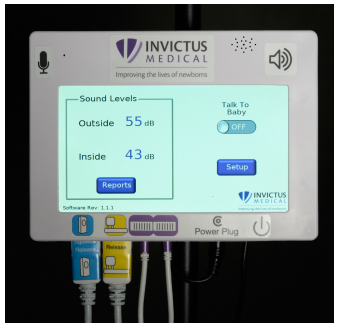
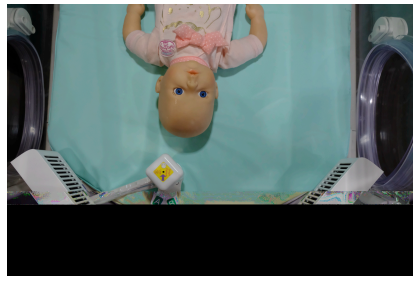
Inquiry

How does a non-contact active noise control device impact alarm noise in a simulated NICU environment?

Methodology

Two measures of the attenuation performance of a non-contact ANC device (Neoasis, Invictus Medical) were conducted.

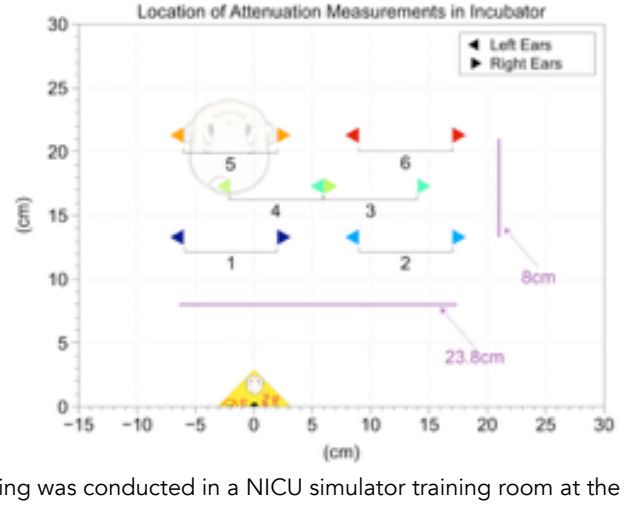




(1) The amount of attenuation produced by the ANC device was compared to the attenuation achieved by adhesive-affixed earmuffs (MiniMuffs, Natus Medical) in response to 11 alarm and voice sound sequences. The sequences were generated by different priority alarms from a patient monitor, an infusion pump, and a ventilator, either alone or in combinations. In a worst case scenario, alarms from all three were combined.

(2) The sound attenuation zone size of the ANC device was measured at six locations (see below) in response to these 11 sound sequences. Attenuation measurements were reported for the louder of the two ears under all test conditions.

Location Of Attenuation Measurements In Incubator



Testing was conducted in a NICU simulator training room at the Children's Hospital of San Antonio. The ANC device was deployed in a Giraffe OmniBed incubator (GE Healthcare).

Results

(1) Comparison Of Attenuation Of ANC Device and MiniMuffs

For seven of the 10 alarm-based sound scenarios, the ANC device had better attenuation than the earmuffs (see below).

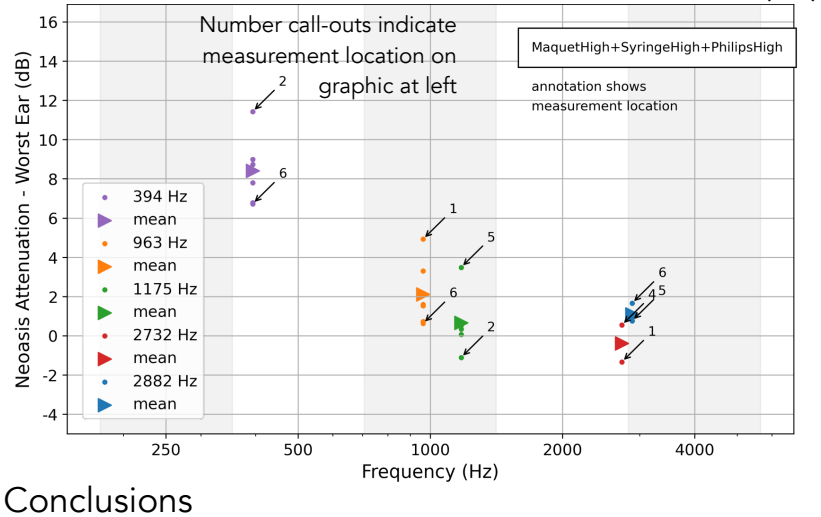
	Attenuation (dB)	
Seq #	ANC Device	Earmuffs
2	11.7	3.5
3	9.4	7.4
4	8.6	2.6
7	7.0	4.4
10	6.5	5.0
8	5.1	0.2
9	3.3	2.7

For the remaining three alarm-based sound scenarios, neither earmuffs or the ANC device provided attenuation greater than a just noticeable difference. The earmuffs provided 4.7dB attenuation for voice signals, greater than that provided by the ANC device.

(2) ANC Device Attenuation Zone Size

Of the 11 sound sequences, alarm sounds with a primary frequency in the 500 Hz octave band were well attenuated throughout the 24cm by 8cm measurement region (6.5 dB to 10.6 dB). For border frequencies (500 Hz to 1 kHz), the two measurement locations nearest the ANC device provided better attenuation than measurement points further away (average of 5.4 dB vs 1.0 dB). For frequencies above 2 kHz, the ANC device provides no further attenuation; however, the SPL inside the incubator for these sound sequences is consistently below 39 dBA, perhaps due to the passive attenuation of the incubator wall.

ANC Device Attenuation At Points In Incubator – Worst Case Scenario (#10)



Conclusions

This ANC device provided superior attenuation to earmuffs that had been shown to impart improved sleep hygiene and weight gain for infants when cared for in NICU incubators. The attenuation zone was largest in lower frequency bands where most of the noise in the NICU is concentrated.