Spectral changes to sound exposure when preterm infants transition from the incubator to an open crib

BACKGROUND

- Preterm infants are at risk for speech and language developmental delays ¹
- They can spend several weeks or months in the neonatal intensive care unit (NICU), transitioning from enclosed incubator to open crib as health improves
- NICU sound environment is considered a risk factor due to noxious noise levels, low speech input, and excessive silenceperiods ^{2,3,4}
- Abrupt changes in sound exposure during NICU stay are another potential, but less well-studied, cause for concern
- Transition from incubator to crib expected to increase high-frequency exposure as incubator walls attenuate sounds above 200 Hz by 10-20 dB ⁵



Low-pass filtering effect of incubator walls. Reproduced with permission from Monson et. al. (2020) ⁵

- However, due to incubator's internal sound sources and occasional removal of infant for care, nature of sound exposure in incubator vs crib is unclear
- Acoustical analyses of sound exposures recorded throughout NICU stay can help characterise the changing environment

AIM

• To compare overall and spectral bandwise sound levels in incubator and crib





LENA DEVICE CALIBRATION

- Speaker-to-mic. distance: 1 m



Rohit M. Ananthanarayana and Brian B. Monson Department of Speech & Hearing Science, College of Applied Health Sciences, University of Illinois Urbana-Champaign

SUBJECTS

37 very preterm (VPT; \leq 32 weeks' gestation) infants in level III, open-layout NICU, Carle Foundation Hospital, Urbana

Inclusion criteria: maternal age \geq 19 years, gestational age \leq 32 weeks

Exclusion criteria: congenital anomaly, infection, prenatal brain lesion

RECORDING PROCEDURE

 LENA ⁶ recorders attached to inside wall of incubator or crib near infant's head





Device attached to armchair when infant removed for care

• Three 24-hr recordings per week on M/W/F or T/Th/Sa until discharge

Random sample of 6 LENA devices (out of 23) calibrated post data-collection

Setup:

- Reference mic.: NTI M2211 ¹/₂" class-1
- Loudspeaker: KRK Rokit 8
- Stimulus: White noise at 66.3 dBC SPL
- Room: Double-walled sound booth





LENA DEVICE CALIBRATION (cont'd)



ANALYSES

- Each 24-hour recording analyzed using overall level and long-term average spectral levels in 3rd-octave bands
- Levels adjusted based on derived calibration factors
- 7 subjects excluded due to lack of recordings from both incubator & crib
- Total of 610 recordings, avg. ≈10 per subject per bed type (min=2, max=30)
- Linear mixed-effects models to assess level differences between incubator & crib

RESULTS

- Sound levels in incubator up to 2.7 dB higher than crib at frequencies < 500 Hz, and 1-4 dB lower above 500 Hz



Average difference in 3rd-octave band levels between reference mic. and LENA devices taken as LENA transfer function

Mean overall sound levels of 66.8 & 66.3 dB SPL in incubator and crib (p<0.001)

CONCLUSIONS

- Incubator is not quieter than crib despite its enclosing walls, likely due to internal sound sources ⁷
- Below 500 Hz, incubator sound levels are up to 2.7 dB higher
- Above 500 Hz, sound levels are up to 4 dB lower in incubator, despite the nearly 20-dB attenuation provided by its walls
- Effects of these small differences are unclear and warrant further investigation
- Future work will involve finer time-scale analyses to identify peak sound levels, durations of exposure to such sounds, and circadian patterns in exposure levels

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