# Sound level exposure for preterm infants in the neonatal intensive care unit

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## Introduction

As early as 23 weeks' gestation, the fetal auditory system begins to function. When an infant is born prematurely, they transition from the mother's womb to the neonatal intensive care unit (NICU), experiencing a rapid change in their physical and acoustical environment.

Studies suggest that preterm infants are at greater risk for auditory dysfunction than full-term infants. It is unknown whether this increased risk is the result of medical factors associated with preterm birth or environmental factors associated with the NICU, but high noise levels and other adverse acoustic exposures have been reported in the NICU.

## Aim

To better understand and characterize the NICU auditory experience, we sought to examine sound pressure level (SPL) exposure and factors that may influence those levels.

## Design

**Recordings:**

- LENA audio recorders
- 24-hr audio recordings, 16-kHz sampling rate
- Hourly and daily $L_{EQ}$ (SPL) estimated from raw recordings


**Population:**

- 27 very preterm (VPT) infants (born ≤ 32 weeks' gestation) during NICU stay at the Carle Foundation Hospital in Urbana, Illinois.

**Factors:**

- Type of oxygen delivery device used
- Bed type (incubator/isolette vs open crib)
- Room type (main unit, small baby unit, secondary unit)
- Time of day (hourly, day vs. night)
- Postmenstrual age (PMA)

## Design (continued)

**Methods:**

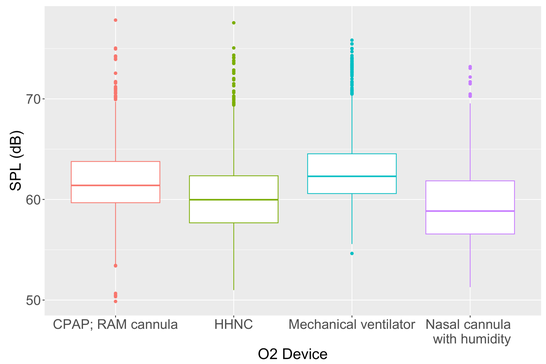
- Audio recordings were collected over 24-hour intervals, 3x per week.
- The LENA was adhered to the inside wall of the infant's incubator or crib (see image below). Devices accompanied infants whenever the infant was removed from the bed.
- A calibration process involving calculating RMS value and determining a calibration factor for each LENA device was used to estimate SPL.
- Electronic medical record (EMR) data for each infant were documented on an hourly basis by the NICU nurses.

*LENA recording device adhered to inside of incubator.*

## Results

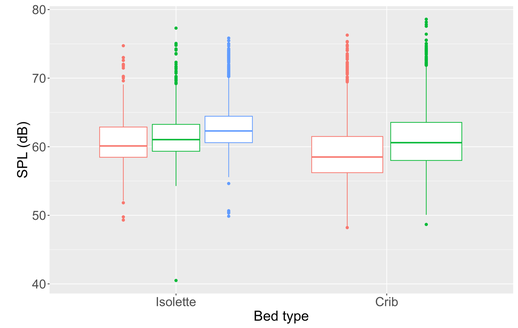
Hourly sound pressure levels for each oxygen device used were analyzed. Preliminary analyses indicate:

- Mechanical ventilator had the greatest intensity (62.9 dB SPL).
- Nasal cannula with humidity had the lowest intensity (59.3 dB SPL).
- All pairwise comparisons between oxygen devices were significant with corrections for multiple comparisons.



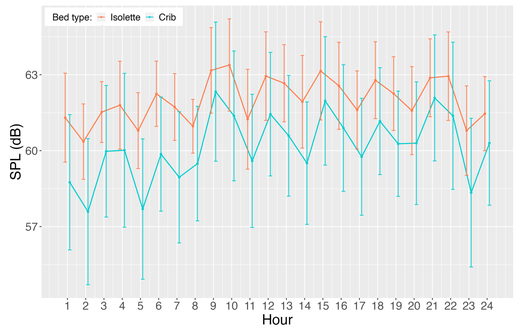

*Hourly $L_{EQ}$ for each type of oxygen device used.*

## Results (continued)




*Hourly $L_{EQ}$ by bed type and room/unit.*

- SPL across the 24-hour time period suggests that the dynamic nature of the acoustic environment in the NICU is underscored by hourly variations and patterns of care times and shift changes.




*Average hourly $L_{EQ}$ for each bed type (incubator vs crib). Hour number indicates prior 60 min to that hour (e.g., hour 1 = 12:00-1:00 AM).*

| *Predictors* | *SPL Estimates* | *p* |
|---|---|---|
| (Intercept) | 65.043 | **<0.001** |
| Bed type [crib] | -0.562 | **<0.001** |
| Room [small baby unit] | 0.690 | **<0.001** |
| Room [secondary unit] | -0.059 | 0.797 |
| PMA | -0.091 | **<0.001** |
| Time category [night] | -1.356 | **<0.001** |
| Bed type [crib] × Room [secondary unit] | -1.325 | **<0.001** |

*Linear mixed-effects model with subject as random factor. Reference condition is an isolette in the LBU during the day.*

**Main effects:**

- All predictors appeared to have a significant effect on the SPL except for the room comparison between the main unit and secondary unit.

**Interaction effect:**

- The impact of bed type (isolette vs crib) on SPL is modified by room.

## Conclusions

- Our data suggest that cribs are quieter than incubators in the NICU and that different rooms/units have different sound level exposures for preterm infants.
- There was an interaction between bed type and room with a larger drop in sound level (~2 dB) when moving from incubator to crib in the secondary unit.
- While the observed differences between predictors are statistically significant, their values are relatively small (~1 dB SPL). Clinical implications for these small differences are not clear.
- Our results suggest infants in cribs are exposed to a wider range of sound levels during the day than infants in incubators.
- Our analysis suggests a decrease of ~0.1 dB per week increase in postmenstrual age (PMA).
- Several factors may influence auditory exposures in the NICU. Whether these factors can be controlled to mitigate adverse auditory exposures remains to be seen.
- It is hoped that this line of study will lead to interventions designed to prevent audiological impairments associated with preterm birth and NICU environmental exposures.

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## References

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