Occupational noise exposure to a dedicated neonatal transport team

Neonatal transport services are a new service provision within the UK NHS. This study assesses the noise exposure to staff working in a neonatal transport service. As with any new service provision, new developments bring new challenges, one of which being the health and safety of the personnel. Staff frequently reported temporary hearing impairment and tinnitus post transfer. This study assesses the noise exposure of a neonatal transport team and compares this exposure to legal limits.

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Key points

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1. During neonatal transfers staff are exposed to peak levels of noise exceeding the upper legal noise exposure limit, but acceptable average noise levels.
2. There are no previously published data on noise exposure to patient transfer teams.
3. This study evidences risk to patient transfer teams worldwide.

Emergency and elective patient transfers may pose risks to both patients and staff[1,2]. To manage these risks, especially to patients, inter-hospital patient transfers are increasingly being undertaken by dedicated teams of specifically trained personnel. In countries such as Canada and Australia such teams have been working for decades, however in the UK this is a more recent trend. This is particularly true of inter-hospital transfers of newborn babies and infants.

Previously in Scotland relatively well babies were transferred by paramedics with sicker babies transferred by a variety of hospital neonatal unit midwives and doctors. The present service ensures that all neonatal transfers are undertaken by a national service (Neonatal Emergency Transport Service – NETS) composed of three *dedicated* teams of doctors, midwives and advanced neonatal nurse practitioners (ANNPs). This service is provided by a core group of ANNPs, doctors and nurses resulting in a smaller number of staff undertaking transfers more frequently than before. In Scotland approximately 1200 transfers are performed per annum, using road ambulances, helicopters and fixed-wing aeroplanes.

As with any new service provision, new developments bring new challenges, one of which being the health and safety of the personnel. There was anecdotal concern from staff in the NETS team that transfers were significantly noisy. Staff frequently reported temporary hearing impairment and tinnitus post transfer.

There is published evidence of occupational noise-induced hearing loss risk to fire fighters[3,4], paramedics[5,6], and even military flight deck personnel[7]. However extensive literature searches provided no data on patient transfer teams. Recent changes to the law have decreased the permitted sound level exposure limits – The Control of Noise at Work Regulations UK 2005[7].

These regulations have action levels and limits for two different categories of noise. The first category is the daily personal noise exposure ($L_{EP,d}$) which is the average noise level an individual is exposed to over the duration of a shift, which is then calculated to an eight-hour time exposure, ie the average working day, for comparison purposes. The second category is the "peak" sound level which is quite simply the loudest, sudden noises.

There are two different action levels and one limit for these two categories of noise (**TABLE 1**). If the lower exposure action level is exceeded, for either $L_{EP,d}$ or peak, then the employee may *request* hearing protection provision and review of the noise source. If the upper exposure action level is exceeded then the employer is *required* to carry out a noise risk assessment and compliance with hearing protection provision. The exposure limit value is the noise level exposure, allowing for the use of hearing protection, which must not be exceeded.

	$L_{EP,d}$	Peak
Lower exposure action level	80dBA	135dB
Upper exposure action level	85dBA	137dB
Exposure limit value	87dBA	140dB

TABLE 1 The Control of Noise at Work Regulations UK 2005.

This study was performed to assess the sound level exposure to staff per shift on neonatal transport, to compare this exposure with the current legislation and then, if necessary, to identify specific areas requiring improvement.

Methods

Personal dose badges measuring noise exposure (Cirrus Research:110A) were worn by staff throughout their shifts. Each dose badge was calibrated prior to use. Data were downloaded after each recording. Measurements commenced at the start of each shift in the transport base and continued until the end of the shift, regardless of whether any transfers occurred.

The west of Scotland NETS team comprises two consultant doctors, two middle grade doctors, six ANNPs and one sister midwife. Every member of staff had at least one shift recorded. The Control of Noise at Work Regulations UK 2005[7] act allows for one week's measurement to be averaged rather than one specific day, if significant variation occurs day to day. In view of this, 30 staff days were analysed in order to mimic one month, to ensure measurement of a representative sample of work.

During each shift each staff member recorded numerous variables to allow data to be analysed later. Staff noted transfer times, direction, mode of transport, location in ambulance, whether the patient was on board on each journey, and use of the siren. Averaged sound level exposure ($L_{EP,d}$(A))and peak sound level (Peak C) were assessed for the whole shift data then compared with legislation. For each individual journey, the equivalent continuous sound level (Leq) was measured from the moment of leaving the referring ward to arrival into the receiving ward, and averaged.

A journey was defined as one specific leg between hospitals. Therefore for one patient transfer the staff may have three journeys because they have to travel:
1. From the base to the referral hospital
2. From the referral to the receiving hospital
3. Back to the base.

High frequency noise is known to cause more hearing damage than low frequency noise. The frequency of the ambulance noise was analysed using a Brüel and Kjær model 2230 precision sound level meter, IEC type I instrument to show how the frequencies changed with different positions, speeds, and road surfaces in the ambulances.

Following review of the data, peak noise levels were further investigated using a Cirrus Research model 811B Class 1 data logging sound level meter to help establish the source of these levels.

FIGURE 1 The Volkswagen ambulances used by the Scottish Neonatal Transport Service teams.

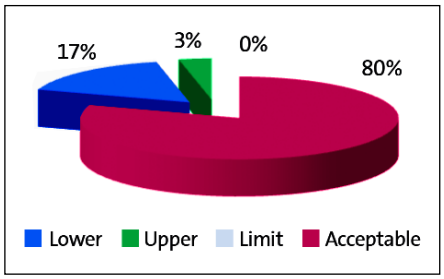

FIGURE 2 $L_{EP,d}$ compared with limits.

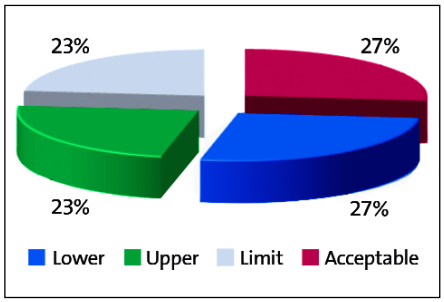

FIGURE 3 Peak noise levels compared with limits.

Results

All members of staff had at least one shift measured. Thirty-one staff shifts were measured (one month equivalent). One was subsequently excluded due to collection error and results are presented on the remaining thirty shifts. The median number of journeys performed per shift was three, (range 0-8) with a total of 109 journeys over these 30 shifts. Shift durations ranged from 4 hours and 53 minutes to 18 hours and 51 minutes with a median duration of eight hours 40 minutes. All of these shifts were time weighted to 8 hours ($L_{EP,d}$).

All transfers during this period were by road ambulance (**FIGURE 1**). The ambulance predominantly used was the Transporter by Volkswagen, with occasional use of a second ambulance by Mercedes – the Voyager.

Comparing the $L_{EP,d}$ data (**FIGURE 2**) to legislated limits (**TABLE 1**) showed that 20% of shifts (6) exceeded the lower exposure action level, whereas only 3% (1) exceeded the $L_{EP,d}$ upper exposure action level. No shifts exceeded the $L_{EP,d}$ limit value. The mean $L_{EP,d}$ was 76.1dB.

However comparing the peak noise levels (**FIGURE 3**) to legislated limits (**TABLE 1**) showed 73% shifts (22) exceeded lower exposure action levels; 47% shifts (14) exceeded upper exposure action level; 23% shifts (7) exceeded the exposure limit value.

Personal noise level meters can record artefact measurements and often give false peak levels through trivial, accidental contact. Examination of the data showed that the peak sound levels recorded were clustered around entering and leaving the vehicle. To discover whether these peak measurements were artefact or real, the ambulances were tested additionally using hand-held noise level meters. This identified three sources of peak noise levels of 123dB to 145dB:

FIGURE 4 Loading the incubator into the ambulance using the tail lift.

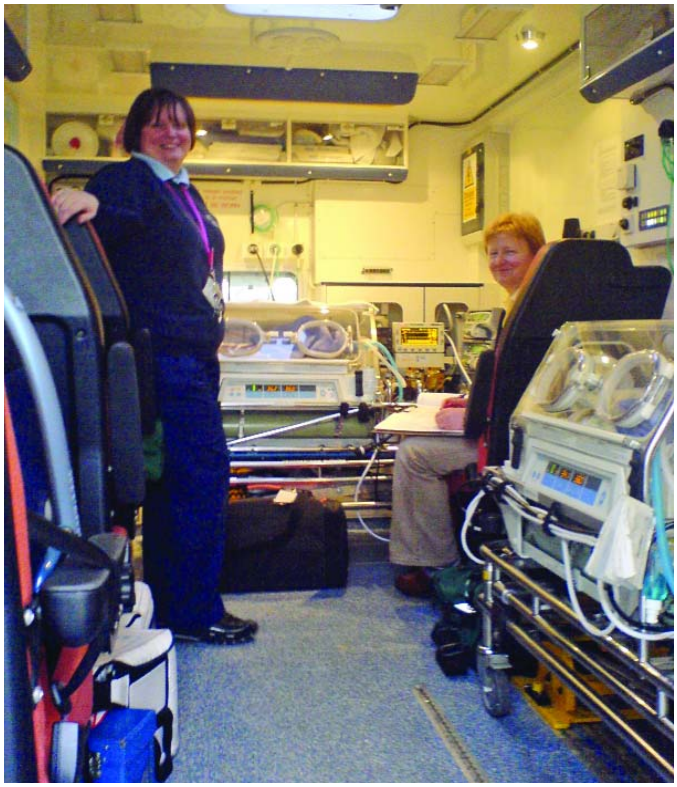

FIGURE 5 Incubators *in situ* and transport underway.

- firstly the point at which the mechanical tail-lift contacts the rear ambulance door on closing
- secondly the noise of the tail lift opening warning alarm (mounted beside the tail-lift control)
- thirdly the noise upon closing the rear ambulance door.

The rear ambulance door could not be successfully closed without enough force to cause 123dB of noise, but often at this force many attempts at closing were required. In order to close the door confidently on first attempt the force required would emit a noise of 134dB and upwards. The noise of the door closing was common to both types of ambulance, but the tail lift problems related to the Transporter (**FIGURE 4**).

During individual journeys, the Leq ranged from 70.6dB to 86.3dB (median 78.9dB). Journeys travelled in the patient area of the ambulance averaged 2.7dB louder compared to the driver compartment (**FIGURE 5**). Journeys with the patient on board averaged 2.5dB louder. Journeys involving intermittent siren use averaged 3.2dB louder.

When measuring the noise frequencies with different positions, speeds, and road surfaces in the ambulances, all other variables were kept as constant as possible. However testing the siren use was technically difficult as the siren is mostly used when travelling on urban roads and even then as sparingly as possible so as not to stress the infant. In the urban setting the vehicle moves at highly variable speeds often with hard braking and acceleration. As such the "siren" results should be interpreted with caution.

The frequency results (**FIGURES 6-9**) generally show the loudest noise tends to occur in the lower frequencies, but that in the rear of the vehicle, furthermore at speed and on a concrete road surface, higher frequency noise is relatively amplified.

Discussion

The principal finding of this study is that staff are exposed to acceptable average noise levels during their shifts in the vast majority of occasions. However this study has identified that almost half of all shifts expose these staff members to peak noise levels above the upper legal noise exposure limit.

The strengths of this study are that this is the first published data of the noise exposure to patient transfer teams and a full month's data was recorded to even out the widely variable workload to staff. The authors believe the study period accurately reflects average workload. The weakness of this study is that these data are specific to this service and future research is required to identify the implications of the research to other services, however this study clearly identifies a risk.

The results of this study show a clear breach of current UK legislation and have prompted urgent review. All staff members now have baseline audiograms performed when entering employment with the neonatal transport service and subsequent annual audiology surveillance has been introduced. Personalised hearing protection has in addition been provided. The hearing protection system purchased preferentially allows sound transmission in the vocal range thus ensuring staff communication and patient alarm recognition is not diminished. Review of the ambulance acoustics and tail-lift system is underway.

The use of the ambulance siren only increased the Leq by 3dB. However due to the logarithmic scale used to measure noise, every 6dB increase is equivalent to a doubling in the noise level. So small changes are significant. Also the small change is likely to be due to very judicious use of the siren in view of stress to the patient and often little benefit to transfer time[8-11].

As a point of note, the regulation allows for exemption of the emergency services for a limited period of time if their work

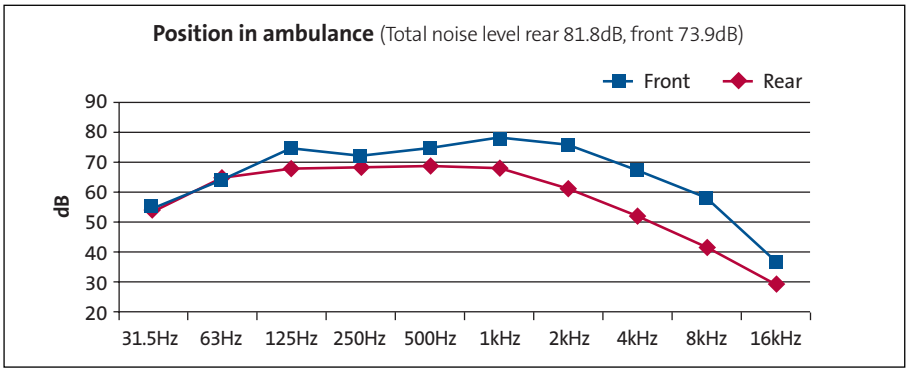

FIGURE 6 Frequency of noise detected in front and rear of ambulance.

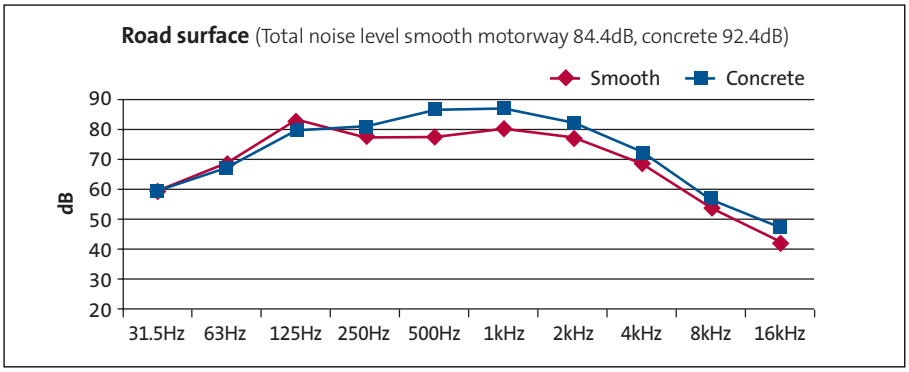

FIGURE 7 Frequency of noise detected on different road surfaces.

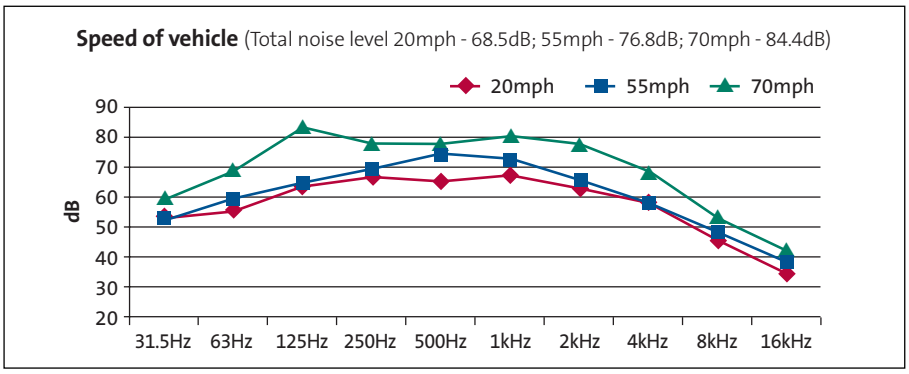

FIGURE 8 Frequency of noise detected at different speeds.

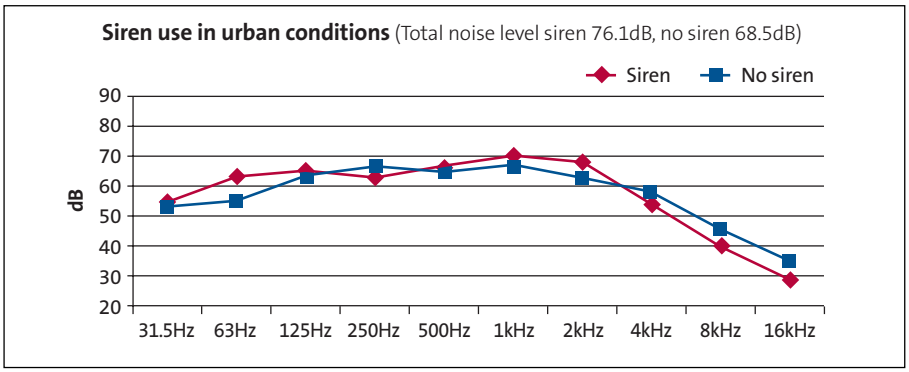

FIGURE 9 Frequency of noise detected with and without the siren.

"conflicts with the requirements" of the regulations. However an exemption will only be granted if the "…health and safety of the employees concerned is ensured as far as possible…" Although sirens and warning alarms are a requirement of the job, it should be possible to isolate the staff from this noise if required. No such exemption has been applied for.

The UK neonatal transport network has been alerted to this risk. The authors believe this data demonstrates emerging risk for patient transport teams worldwide. In addition to the risk to patient transport teams, this study highlights the need to investigate the noise exposure to babies on transfer. The authors are currently studying this as well as any resultant hearing loss caused and aim to publish the results shortly.

Acknowledgement

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