General

The Characteristics of Pure Tone Audiograms in a Sample of Royal Marines After Operation Herrick 9

C Pearson

Introduction
Estimation of the incidence of noise-induced hearing loss sustained in the course of current operations requires both pre- and post-deployment pure tone audiometry. In a study of reserve personnel who deployed to Operation Herrick 6, 10% of personnel had good audiometric evidence to support a diagnosis of noise-induced hearing loss and a further 32% had audiograms that suggested it. A sample of personnel of 42CDO were the subject of a recent study which intended to compare pre-and post-deployment audiometry conducted by medical centre personnel as well as to validate the medical centre audiometry against formal audiometry by Defence Audiology Service audiologists. The former aim was not successful, because too few subjects had had adequate predeployment audiometry. Therefore any estimate of the extent of NIHL is limited to an estimate of the prevalence. This study aims to estimate the prevalence of NIHL based upon the DAS audiometry.

The accepted criteria required for a diagnosis of NIHL are: (1) an high frequency impairment; (2) noise exposure; (3) an audiometric configuration of a notch or bulge. It goes without saying that criteria (1) and (3) may be derived from analysis of the audiogram. Although data exist on the loudness of various military vehicles and weapons, no data were available for the exposure for individual personnel. The statutory daily peak exposure limit value is 140 dB(C), which is exceeded by a single SA80 round when fired without any form of protective equipment. Anecdotal evidence is that troops fire thousands of rounds of various types in a deployment. The current personal interfaced hearing protection was not available for Op Herrick 9. It is therefore considered reasonable to assume that all troops were exposed to an excessive amount of noise.

Method
181 subjects had pure tone audiometry conducted by DAS audiologists using the standard approved method during October and November 2009. It is unclear how personnel were selected.

Data were entered into a spreadsheet by INM clerical staff and analyzed using software written by the author.

PULHHEEMS “H” grades were calculated according to JSP346.

For the purpose of comparison, routine screening audiograms obtained from the population at RAF Wittering in 1999 for use in a previous study were used. Chisquared test was used to determine statistical significance.

Results
The numbers of personnel with a notch or bulge at increasing depths and stratified according to length of service is shown in table 1. (The length of service was not recorded in one case.)
Of the 124 audiograms that showed a notch or bulge of 10 dB or greater, the right was worse in 29 subjects (23%); the left worse in 68 subjects (55%) and the remaining 27 subjects (22%) were symmetrical, i.e. the difference between the depths was less than 5 dB.

Taking a notch or bulge of 15 dB or greater as the criterion, the right ear only was positive for NIHL in 21 subjects (12%); the left only positive in 45 subjects (25%); both ears positive in 19 (10%) and the remaining 96 (53%) were negative in both ears.
Table 2: “H” grades

<table>
<thead>
<tr>
<th>grade</th>
<th>number</th>
<th>Proportion(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>114</td>
<td>63.0</td>
</tr>
<tr>
<td>H2</td>
<td>51</td>
<td>28.1</td>
</tr>
<tr>
<td>H3</td>
<td>15</td>
<td>8.3</td>
</tr>
<tr>
<td>H4</td>
<td>1</td>
<td>0.6</td>
</tr>
</tbody>
</table>

A comparison of the prevalence of notches (at different thresholds of depth) between 42CDO and RAF Wittering is shown in table 3.

Table 3: prevalence of notches or bulges at different thresholds

<table>
<thead>
<tr>
<th>depth threshold</th>
<th>42CDO</th>
<th>RAF</th>
<th>Wittering</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 dB1 notch</td>
<td>124</td>
<td>588</td>
<td>47%</td>
</tr>
<tr>
<td>no notch</td>
<td>57</td>
<td>666</td>
<td></td>
</tr>
<tr>
<td>15 dB2 notch</td>
<td>85</td>
<td>309</td>
<td>25%</td>
</tr>
<tr>
<td>no notch</td>
<td>96</td>
<td>945</td>
<td></td>
</tr>
<tr>
<td>20 dB3 notch</td>
<td>59</td>
<td>151</td>
<td>12%</td>
</tr>
<tr>
<td>no notch</td>
<td>122</td>
<td>1103</td>
<td></td>
</tr>
</tbody>
</table>

1chi-squared = 29.57 p « 0.001
2chi-squared = 39.56 p « 0.001
3chi-squared = 53.50 p « 0.001

Discussion

The original research protocol did not specify any method of sample selection and there is no evidence that there was any attempt at randomization. There have been anecdotal reports of personnel who are aware of hearing impairment avoiding audiometry in order to avoid medical downgrading. This factor would bias the results in favour of an underestimate of the true prevalence of NIHL.

A notch (or bulge) is necessary, but not sufficient, for a diagnosis of NIHL. Notches may occur sporadically rather than being due to noise. This factor would tend to produce an overestimate of the true prevalence of NIHL. Care should be taken in making a diagnosis on the basis of a single audiogram, despite the fact that DAS audiologists audiometry has been shown to be highly accurate. What can be stated with a high degree of confidence is that this study shows that if the threshold for a notch is 10 dB, then 31% of personnel do not have NIHL and if the threshold is 15 dB, which gives a higher degree of specificity for finding NIHL at the expense of sensitivity, then 53% of personnel do not have NIHL.

There was no evidence of active middle or outer ear disease in any of the study population, but other causes of hearing impairment were not excluded. This is unlikely to have influenced the estimate of NIHL significantly.

The prevalence of notches (or bulges) in this study (table 3) is higher (to a very high degree of statistical significance) than that in the pre-Telic/pre-Herrick population of RAF personnel whether the threshold for defining a notch is at 10 dB, 15 dB or 20 dB.
In approximate terms, the 1999 baseline represents two-thirds, one-half and one-third of the notches in this study at each threshold respectively. It follows that it would be a gross exaggeration to assert that 69% of personnel had sustained NIHL during Op Herrick 9. The difference of 22% is probably a more accurate estimate. Although the two samples have not been matched for age and sex, this does seem to be convincing evidence that current deployments are particularly injurious to the ears.

Improved personal protective equipment was introduced in the following deployment and it is hoped that a future similar study would show a reduction in NIHL. The presence of a mild notch (less than 20 dB) is loosely correlated with length of service, but the proportion of personnel with a 20 dB or greater notch did not vary with length of service. The data do not explain why this is the case, but it is possible to make an educated guess. If there is a mild degree of excess noise in normal peacetime service (from vehicles or occasional firing of weapons) it may be expected that the severity of NIHL would be closely related to length of service. If, however, Op Herrick 9 led to a severe degree of hearing loss, affected personnel would end up with a severe loss (i.e. 20 dB or greater) whether they had been normal or only mildly impaired beforehand. This suggests that personnel who are unprotected in the high tempo environment of current operations are subject to a particularly high risk of NIHL. It is hoped that developments in personal protective equipment will have reduced this risk.

The magnitude of the risk of NIHL can only be estimated accurately by undertaking good quality pre-and post-deployment audiometry. Similarly, demonstration of the effectiveness of PPE will require comparison of pre-and post-deployment audiometry in protected personnel compared with unprotected personnel. Given that another limb of this study has shown that medical centre screening audiometry is less accurate than formal audiometry, it will not be possible to rely upon the former. Resources will be required to provide research-standard audiometry and time will have to be set aside in order for personnel to participate.

Conclusion
Assuming that all personnel are at risk of excessive noise exposure, if the lowest reasonable threshold (10 dB) for a high frequency notch is taken as a criterion for NIHL, then 69% of 42CDO personnel had evidence of NIHL after Op Herrick 9. If the threshold is raised to 15 dB, the prevalence is 47%. Comparison with an earlier study suggests that the excess over a non-exposed military population is 22%.

References
2. MoDREC Protocol no: 0925/250; reported as INM Report 2010.042
6. INM Report 2009.031
7. INM Report 2010.042