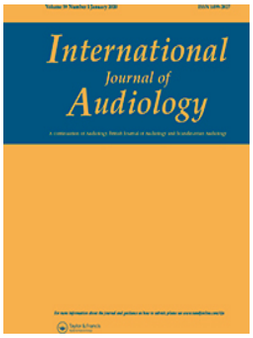

International Journal of Audiology

ISSN: 1499-2027 (Print) 1708-8186 (Online) Journal homepage: https://www.tandfonline.com/loi/iija20

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To cite this article: Christopher G. Brennan-Jones, Karina F.M. Tao, Christina Tikka & Thais C. Morata (2020) Cochrane corner: interventions to prevent hearing loss caused by noise at work, International Journal of Audiology, 59:1, 1-4, DOI: 10.1080/14992027.2019.1633479

To link to this article: https://doi.org/10.1080/14992027.2019.1633479

INTERNATIONAL JOURNAL OF AUDIOLOGY
2020, VOL. 59, NO. 1, 1–4
https://doi.org/10.1080/14992027.2019.1633479

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COCHRANE CORNER

Cochrane corner: interventions to prevent hearing loss caused by noise at work

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ABSTRACT

This Cochrane Corner features "Interventions to prevent hearing loss caused by noise at work", published in 2017. The aim of this Cochrane Review was to find out if hearing loss caused by noise at work is being prevented by current interventions. Tikka et al. identified 29 studies that studied the effect of preventive measures. One study evaluated legislation to reduce noise exposure, eleven studies evaluated effects of personal hearing protection devices and 17 studies evaluated effects of hearing loss prevention programmes (HLPPs). There was some very low-quality evidence that implementation of stricter legislation can reduce noise levels in workplaces and moderate-quality evidence that training of proper insertion of earplugs significantly reduces noise exposure at short-term follow-up. This Cochrane review has identified specific strategies that have shown effectiveness in reducing workplace noise, such as the implementation of stricter legislation and the need for training in the proper use of earplugs and earmuffs to reduce noise exposure to safe levels. The overall quality of evidence for the effectiveness of HLPPs in preventing hearing loss was very low, there was limited follow-up of participants receiving training for insertion of earplugs and no controlled studies examining engineering controls to reduce workplace noise.

ARTICLE HISTORY
Received 17 March 2019
Revised 12 June 2019
Accepted 14 June 2019

KEYWORDS
Hearing loss; occupational health; cochrane

Introduction

Worldwide, occupational noise exposure accounts for 16% of disabling hearing loss in adults (Leigh et al., 1999). Noise-induced hearing loss is the second most common self-reported occupational illness or injury, despite decades of study, workplace interventions, and regulations (Nelson et al. 2005). In the US alone, it has been estimated that two-and-a-half healthy life years are lost each year for every 1000 noise-exposed US worker because of hearing impairment.

It is hypothesised that the most effective way to reduce occupational noise and its adverse effects is to apply control measures in a hierarchical order (Ellenbecker 1996). This means first using measures that eliminate the source of the noise for all workers, down to implementing measures that protect the individual worker only. Despite the consensus that this should be the leading principle for noise reduction strategies at the workplace, the first attempt to reduce noise often seems to be limited to the provision of hearing protectors.

A non-systematic review on the effectiveness of hearing conservation programmes conducted in 1995 concluded that there was no convincing evidence that HLPPs are effective (Dobie, 1995). The present Cochrane review evaluated interventions that aim to reduce occupational exposure to noise or to decrease occupationally induced hearing loss (Tikka et al. 2017).

Full Cochrane review abstract from Tikka et al. (2017)

Background

This is the second update of a Cochrane Review originally published in 2009. Millions of workers worldwide are exposed to noise levels that increase their risk of hearing disorders. There is uncertainty about the effectiveness of hearing loss prevention interventions.

Objectives

To assess the effectiveness of non-pharmaceutical interventions for preventing occupational noise exposure or occupational hearing loss compared to no intervention or alternative interventions.

Search methods

We searched the CENTRAL; PubMed; Embase; CINAHL; Web of Science; BIOSIS Previews; Cambridge Scientific Abstracts; and OSH UPDATE to 3 October 2016.

Selection criteria

We included randomised controlled trials (RCT), controlled before-after studies (CBA) and interrupted time-series (ITS) of non-clinical interventions under field conditions among workers to prevent or reduce noise exposure and hearing loss. We also collected uncontrolled case studies of engineering controls about the effect on noise exposure.

Data collection and analysis

Two authors independently assessed study eligibility and risk of bias and extracted data. We categorised interventions as

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engineering controls, administrative controls, personal hearing protection devices, and hearing surveillance.

Main results

We included 29 studies. One study evaluated legislation to reduce noise exposure in a 12-year time-series analysis but there were no controlled studies on engineering controls for noise exposure. Eleven studies with 3725 participants evaluated effects of personal hearing protection devices and 17 studies with 84,028 participants evaluated effects of hearing loss prevention programmes (HLPPs).

Effects on noise exposure

Engineering interventions following legislation

One ITS study found that new legislation in the mining industry reduced the median personal noise exposure dose in underground coal mining by 27.7% points (95% confidence interval (CI) −36.1% to −19.3% points) immediately after the implementation of stricter legislation. This roughly translates to a 4.5 dB(A) decrease in noise level. The intervention was associated with a favourable but statistically non-significant downward trend in time of the noise dose of −2.1% points per year (95% CI −4.9 to 0.7, 4-year follow-up, very low-quality evidence).

Engineering intervention case studies

We found 12 studies that described 107 uncontrolled case studies of immediate reductions in noise levels of machinery ranging from 11.1 to 19.7 dB(A) as a result of purchasing new equipment, segregating noise sources or installing panels or curtains around sources. However, the studies lacked long-term follow-up and dose measurements of workers, and we did not use these studies for our conclusions.

Hearing protection devices

In general hearing protection devices reduced noise exposure on average by about 20 dB(A) in one RCT and three CBAs (57 participants, low-quality evidence). Two RCTs showed that, with instructions for insertion, the attenuation of noise by earplugs was 8.59 dB better (95% CI 6.92–10.25 dB) compared to no instruction (2 RCTs, 140 participants, moderate-quality evidence).

Administrative controls: information and noise exposure feedback

On-site training sessions did not have an effect on personal noise-exposure levels compared to information only in one cluster-RCT after four months' follow-up (mean difference (MD) 0.14 dB; 95% CI −2.66 to 2.38). Another arm of the same study found that personal noise exposure information had no effect on noise levels (MD 0.30 dB(A), 95% CI −2.31 to 2.91) compared to no such information (176 participants, low-quality evidence).

Effects on hearing loss

Hearing protection devices

In two studies the authors compared the effect of different devices on temporary threshold shifts at short-term follow-up but reported insufficient data for analysis. In two CBA studies the authors found no difference in hearing loss from noise exposure above 89 dB(A) between muffs and earplugs at long-term follow-up (OR 0.8, 95% CI 0.63–1.03), very low-quality evidence). Authors of another CBA study found that wearing hearing protection more often resulted in less hearing loss at very long-term follow-up (very low-quality evidence).

Combination of interventions: HLPPs

One cluster-RCT found no difference in hearing loss at three- or 16-year follow-up between an intensive HLPP for agricultural students and audiometry only. One CBA study found no reduction of the rate of hearing loss (MD −0.82 dB per year (95% CI −1.86 to 0.22) for a HLPP that provided regular personal noise exposure information compared to a programme without this information.

There was very-low-quality evidence in four very long-term studies, that better use of hearing protection devices as part of a HLPP decreased the risk of hearing loss compared to less well used hearing protection in HLPPs (OR 0.40, 95% CI 0.23–0.69). Other aspects of the HLPP such as training and education of workers or engineering controls did not show a similar effect.

In three long-term CBA studies, workers in a HLPP had a statistically non-significant 1.8 dB (95% CI −0.6 to 4.2) greater hearing loss at 4 kHz than non-exposed workers and the confidence interval includes the 4.2 dB which is the level of hearing loss resulting from 5 years of exposure to 85 dB(A). In addition, of three other CBA studies that could not be included in the meta-analysis, two showed an increased risk of hearing loss in spite of the protection of a HLPP compared to non-exposed workers and one CBA did not.

Authors' conclusions

There is very low-quality evidence that implementation of stricter legislation can reduce noise levels in workplaces. Controlled studies of other engineering control interventions in the field have not been conducted. There is moderate-quality evidence that training of proper insertion of earplugs significantly reduces noise exposure at short-term follow-up but long-term follow-up is still needed.

There is very low-quality evidence that the better use of hearing protection devices as part of HLPPs reduces the risk of hearing loss, whereas for other programme components of HLPPs we did not find such an effect. The absence of conclusive evidence should not be interpreted as evidence of lack of effectiveness. Rather, it means that further research is very likely to have an important impact.

Footnote: This Abstract is taken from a Cochrane Review previously published in the *Cochrane Database of Systematic Reviews* 2017, Issue 7, Art. No.: CD006396. DOI: 10.1002/14651858.CD006396.pub4 (see www.cochranelibrary.com for information). Cochrane Reviews are regularly updated as new evidence emerges and in response to feedback, and *Cochrane Database of Systematic Reviews* should be consulted for the most recent version of the review. The views expressed in this

summary are those of the authors and in no way represent the Cochrane Library or Wiley publishers.

Commentary on the Cochrane review

One of the key aims of the IJA Cochrane Corner is to gain some additional insights into the implications of Cochrane reviews for clinical practice. Each review is a significant undertaking for the authorship teams, and they are essential in developing the evidence-base within audiology. Here we present questions regarding the key clinical and research implications of this review with answers from the Cochrane review authors, Dr Morata and Dr Tikka.

Question (Brennan-Jones): What do you see as the most effective way to decrease noise exposure for workers?

Answer (Morata): In practice (and from the studies we located), the provision of hearing protection devices (HPDs) is the most common approach to reduce noise exposure. But in the field of occupational health, a hierarchy of controls that prioritises controlling the source of exposures, is recommended for being less burdensome to workers and less dependent on behaviour than those involving HPDs. In some settings one cannot eliminate or relocate the noise source. In those instances, personal hearing protection becomes the necessary approach. But in the vast majority of cases, noise control via engineering or administrative controls is understood to be the strategy that would substantially reduce the risk of illness or injury. So why is it not more commonly adopted? Cost is usually the first argument presented against noise control. While retrofitting equipment and machinery to be less loud can be very costly, examples from industry showing that noise control can be a cost-effective primary preventive strategy can be found online (See http://www.safeinsound.us/winners.html) and https://www.osha.gov/dts/osta/otm/new_noise/ and (Morata & Meinke, 2016). Unfortunately, the evidence of the effectiveness of specific interventions or hearing loss prevention programmes that include several components is weak; there may be some preventive effect but it may not fully cancel out the effects of exposure. The available evidence makes it difficult to draw more definite conclusions.

Question (Brennan-Jones): You found that engineering solutions might lead to similar noise reduction as hearing protection, but there was a distinct lack of controlled studies in this area. Can you detail what types of engineering solutions and how these could best be monitored? Is there sufficient evidence to recommend legislation to compel companies to make these improvements?

Answer (Tikka): All case studies showed a reduction in noise levels, which is a real indication for companies to invest in engineering controls, such as new equipment, acoustic panels and curtains, or damping material, rather than rely on personal hearing protection alone. But the findings have limitations. The absence of a control group in many studies was not the biggest issue as it is difficult to imagine other factors that might have diminished noise levels in work places. But other issues exist, such as the lack of accurate personal noise exposure levels before and after the intervention and the lack of long-term follow-up measurements. When noise levels are only measured for the machinery, it remains unclear how much the worker's exposure has been reduced. Personal noise dosimetry would be a better option to report the results of the intervention. In addition, we need long-term follow up to evaluate if the attenuation lasts after the installation of engineering controls. There is anecdotal evidence that engineering controls are removed for efficiency reasons or they wear down after longer use.

Question (Brennan-Jones): This review highlighted the importance of correct use of hearing protection such as earplugs, with instructions for insertion of earplugs increasing noise attenuation by 7 to 10 dB (A). Are generic instructions available that could be used across workplaces for earplugs from various manufacturers, or should the instructions be manufacturer-specific to be effective?

Answer (Tikka): At least for basic roll-down foam earplugs instructions do not need to be manufacturer-specific; the process is very similar across brands and types. But what the evidence shows is that personal instructions result in higher noise protection ratings for workers than the instructions commonly found on the packages which are not very specific. Personal instruction would mean someone is actually showing it and doing it together with the worker. A major problem is that people do not insert them deep enough into the ear canal which can be problematic when a person has a narrow canal (Salmani Nodoushan et al., 2014). Technology now allows one to objectively measure the attenuation provided by HPDs, which could improve the benefit they provide, as well as the effectiveness of training efforts (Byrne et al., 2017; Park and Casali, 1991).

Question (Tao): External factors such as the use of personal listening devices (e.g. headphones/earphones) during leisure time or even working hours could be a confounder for identifying occupational NIHL. Was this variable addressed or adequately controlled for in the studies you reviewed?

Answer (Morata): To judge the risk of confounding bias for studies measuring hearing loss, we decided that the age and hearing loss of the intervention and control group participants should be comparable at baseline. It is important to realise that noise sources external to the workplace would only confound the results of hearing protection if external noise is related to both the intervention and the outcome. When compared with the high levels of occupational noise found in workplaces like construction sites, non-occupational noise exposures generally present little additional exposure for most workers (Neitzel et al. 2004). However, considerable differences in the use of personal listening devices between intervention and control group could have confounded the results, if subjects were found to be consistently listening for an average of 8 hours/day, 5 days a week, for decades, at levels which require mandatory hearing protection in the occupational setting.

Question (Tao): Your review shows that there is some evidence to support several interventions for reducing workplace noise exposure. Perhaps a combination of interventions would be needed to reach safe noise levels that would prevent NIHL. Were there any studies that examined achieving safe listening levels in the workplace as an outcome (instead of noise reduction alone), and do you think there is value in such an approach?

Answer (Tikka): It would be difficult to use "Safe listening level" as an outcome, as there is no worldwide consensus to where this level would be. Also, if we talk about reduction of noise exposure to below 80 dB(A) as a safe level, an intervention that decreases noise levels by e.g. 10 dB might be enough to reach levels below 80 dB(A) in one workplace but not in another. In order to compare interventions and apply the ones that are working we need outcome measures such as exposure dose and noise level.

Question (Tao): The quality of the evidence reviewed was rated for each study and ranged from very poor to moderate, depending on the specific intervention which was evaluated.

What are implications for research and practice, when one takes that into account?

Answer (Morata): Apparently, evaluation of effectiveness of interventions has not been a high priority for stakeholders or researchers. However, our review shows that better implementation is needed because the current studies do not show large effects. This absence of conclusive evidence should not be interpreted as evidence of lack of effectiveness. Rather, it means that further research is very likely to impact the conclusions we reached. We considered the quality of most included studies as low because they used study designs that were at high risk of bias such as comparing two groups of workers of which one uses the intervention and the other not. In these studies, the relation between intervention and outcome gets easily confounded by other factors such as the type of job or differences in age. However, we included also good quality randomised controlled trials which shows that it is possible to conduct these types of studies.

Useful information for researchers on quality of studies and the body of evidence can also be found in the full Cochrane review (Figure 1 - PRISMA Study flow diagram and Figure 2 - Risk of bias graph). We also make specific methodological considerations throughout the Methods and Results sections, such as: "For studies measuring hearing loss, the age and hearing loss of the intervention and control group participants should be comparable at baseline" and "We only included studies that compared different devices worn by the same workers because the evaluation depends to such a great extent on the wearer. That criterion excluded a great number of studies that evaluated different devices worn by different workers. However, this provides us with more reliable results of the effect."

Conclusions

This review highlights that hearing loss prevention interventions can be successful in modestly reducing noise exposure in the workplace. However, the quality of research in this field requires improvement and better implementation of noise control measures and hearing protection are still needed. Further high-quality studies, such as randomised controlled studies with long-term follow-up or interrupted time-series analysis studies, are needed and have the potential to substantially alter the conclusions of the review, when it is next updated.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

CBJ is supported by a National Health and Medical Research Council Fellowship (#1142897).

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