



ARC Sound Practice Project

Final Report

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**Australian Government
Australian Research Council**



sydney symphony orchestra

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FOREWORD

Following the publication of the Australian Government commissioned Strong Orchestra Review Report in 2005, several recommendations were made regarding the ongoing OH & S practices and policies of Australian Orchestras. Of pertinence to this study was Recommendation 12, which stated that ***“Governments should provide one-off financial support of \$0.5 million to engage specialist services to develop and implement improved occupational health and safety injury prevention strategies in the eight professional orchestras.” (Strong Report, 2005, page 81).***

The Sound Practice Project team was established in direct response to this recommendation, and with these funds and the support of the national group of orchestras, applied and successfully received an additional \$734,000 from the Australia Research Council. This substantial funding allowed the team to develop and implement the first comprehensive, multidisciplinary and specific series of occupational health and safety assessments and interventions for orchestral musicians within the major state Australian Orchestras.

This project has been the first of its kind internationally – investigating musicians’ health status and supplying a wide range of interventions, including physical, auditory, psychological and nutritional components. The significance and success of this project has spurred many other countries to follow this example, with several larger scale studies under way in the UK and Germany.

Part of the project has been to understand the existing health and safety issues and policies of professional musicians and Orchestras within Australia, and to evaluate where changes may reasonably be made to comply with existing legislation. The specialised nature of orchestral work requires careful research to refine guidelines to best suit this particular working population.

The project created a unique collaboration research between Australia’s premier state orchestras and a team of internationally recognized researchers in the fields of occupational and music medicine from The University of Sydney. These collaborative arrangements provided the opportunity to redress major gaps in prevention and intervention within occupational health and safety science for orchestral musicians. Recommendations have been made towards sustainable and healthy careers in music based on evidence from the project, with suggestions provided toward future studies needed.

This report would not have been possible without the collaboration and co-operation of all the Sound Practice Project partners who have invested time, support and encouragement in the various projects. The authors of the Sound Practice Project Report would like to formally acknowledge the wide group of people involved in the project. The participating musicians were actively involved, enthusiastic and supportive of the project; the liaison officers and orchestral managers facilitated the Sound Practice team’s implementation of research trials and interventions. The loyal, committed and hardworking research assistants, community-based physiotherapists, administrative staff, University and Orchestral staff and the Sound Practice Health team have all contributed to making the project a reality.

EXECUTIVE SUMMARY

Introduction

The Sound Practice Project answered the call from the government-commissioned Strong report (2005) for the development and implementation of the first-ever national occupational health and safety policies and practices for orchestral musicians. A team of University of Sydney academics led by Dr Bronwen Ackermann, Professor Dianna Kenny and Professor Tim Driscoll received substantial additional funding from the Australia Research Council Linkage Scheme (\$735,000) to boost the cash and in-kind contributions from the Australia Council for the Arts and the eight major orchestras of Australia to allow a truly comprehensive project to be undertaken – the first of its kind internationally. With the recent introduction of the new harmonised *Work Health and Safety Act* (2012), the information from this study will assist in the development of guidelines for work health and safety within the orchestral environment.

Sound Practice Project-Assessments

The Sound Practice Project was a five-year study involving baseline evaluation, development and implementation of musician-specific work health and safety initiatives in response to the recommendations of the Strong Report (2005). Firstly, a cross-sectional population-based physical and psychological health survey and a physical assessment were conducted concurrently followed by an auditory health assessment. A baseline evaluation was required to establish a national database of the physical and psychological characteristics of the musicians so that further assessments and interventions could be targeted to specifically meet the needs of Australian orchestral musicians. The first series of evaluations comprised a self-report survey that evaluated demographics information, pain profiles and physical and psychological characteristics of the musicians as well as a thorough physical examination completed by a team of trained and experienced physiotherapists Australia-wide.

Sound Practice Project-Interventions

Using the baseline information, new assessment protocols were developed, and targeted injury prevention initiatives were designed and implemented. Many new and innovative interventions were added to improve musicians' health. These included specific exercise and Alexander technique programs, on-site health advisory services, a national hearing review, biomechanical performance assessment and embouchure assessment. Education programs were regularly conducted on injury prevention and management, music performance anxiety management, and hearing conservation. The results of these evaluations and interventions will provide the foundations for ongoing occupational health and safety guidelines to use best evidence to prevent injuries and effectively manage injured musicians.

Conclusion

The professional orchestral musician remains susceptible to a range of workplace health and safety risks but exposures vary between orchestras and instruments. The guidelines developed as a result of the Sound Practice Project are a world first attempt to form a benchmark for the Music Performing Arts industry that is relevant both nationally and internationally. The injury management pathway (See Appendix 6) gives advice and a structured response for musicians, management and health professionals to follow or use as a guide in responding to the injured musician.

Sound Practice Project General Findings

1. Education

Education, the best form of prevention, forms the cornerstone of all recommendations from the Sound Practice Project. Educational recommendations include a formal induction program for all new orchestra members and ongoing WH&S education to all orchestra members. Education programs should include all aspects of self-care including physical, psychological, nutritional and hydration information and best practice recommendations.

2. Management of health issues

The best practice management of injuries to professional musician needs to include early reporting and management of work-related injuries with clear and formal protocols regarding health pathways established.

3. Promotion of positive health culture

There needs to be an encouragement of a positive cultural health shift in both musicians and management which includes prioritising induction, mentoring and formal assistance pathways to facilitate better injury management and WH&S policies and procedures.

4. Physical preparedness

The concept of the musical athlete needs to be acknowledged and embraced by musicians, management and health professionals. Comprehensive and specific fitness and wellness strategies need to be undertaken to prevent and also manage injuries. These need to include core strengthening of trunk and supporting playing musculature and prevention of overload, tension-reduction techniques and general cardiovascular fitness.

5. Focus on injury prevention

As part of a wellness and health-focused culture both musicians and management need to be aware of the workload requirements of musicians. This includes consideration of repertoire schedule, rehearsals and player rotations. Preventive measures which include regular education programs, good nutrition and hydration practices, management of external activities (teaching loads) and short term treatment interventions during intensive periods are a vital part of the self- management recommendations made.

6. On-going identification and awareness of issues

Injury surveillance allows ongoing identification of orchestra-specific risk factors that may negatively affect the health and well-being of professional musicians. The orchestral surveillance tool developed by the Sound Practice Project can be implemented and utilised by orchestras into the future. The establishment of a musician health committee would also allow earlier identification of potential health concerns and injury risk factors.

7. Sound

Orchestral musicians are exposed to sound levels that may risk permanent damage to their hearing. There needs to be an integrated approach to prevention of noise-induced hearing loss based on available evidence. This should include initial training and annual follow-up training on hearing conservation practices, regular monitoring of noise exposure and use of anti-noise devices.

8. Mental health

The complex area of psychological health in musicians needs to incorporate psychological screening and awareness of the need for vigilance by health practitioners in detecting early warning signs of psychological distress. Orchestras need to address the situational triggers that exacerbate psychological vulnerabilities in musicians. These include how feedback is provided to musicians by conductors, section leaders and management; zero tolerance policy with respect to bullying; provision of a caring and supportive work environment; and clear expectations in WHS policies with respect to work safety – both physical and psychological. Promotion of psychological well-being can be facilitated through induction processes for new members of the orchestra that includes a psychological self-management component. Musicians need to be able to recognise and manage symptoms of over-arousal and panic and understand how this can progress to chronic music performance anxiety if left untreated.

Future Directions

1. Refining models of musculoskeletal examination to include instrument specific evaluation.

There needs to be more musculoskeletal research to improve the management of PRMDs in this hyper-functioning population.

2. Further exploration of the complex relationship between psychological health and physical factors.

There needs to be a more holistic approach to injury management and musician engagement. Clinical management needs to aim for full functional recovery and careful planning of return to play pathways.

3. Continuing to explore effective ways of protecting hearing without damaging the ultimate performance goal of beautiful music production.

There needs to be comprehensive, bespoke hearing conservation strategies which are evidence –based, carefully implemented and adapted by individual orchestras.

4. Further trial and modification of on-line approach to musician surveillance.

Data can be used in the future to examine in detail the apparent relationship between playing related and other exposures and occurrences of musculoskeletal disorders.

5. Implementing health surveillance to assess causal mechanisms for physical and mental health concerns

The main causes of injury relate to poor practice planning and scheduling. Musicians and management need to be aware of these causal factors in injury to allow injury prevention pathways to be further developed.

SUMMARY OF RECOMMENDATIONS

Education

Education is the cornerstone of occupational health, as increasing the understanding and self-efficacy of musicians in relation to their health is likely to decrease the risk and severity of playing-related injuries and other playing-related health issues.

1. Ongoing education and training of all musicians and orchestral staff, and comprehensive induction of new staff with regards to playing-related health is required. This should include:
 - a. Increasing awareness of the role of preventive measures to improve health. These musician-focused topics might reasonably include:
 - i. Creation of a formal induction process for new members of the orchestra, and updates for on-going members, covering typical physical and psychological health issues.
 - ii. Adjusting practice patterns, diet, external activities and schedules where possible when playing particularly intensive repertoire.
 - iii. Using off-instrument warm-up activities in pre-performance routines.
 - iv. Maintaining physical and psychological health habits in busy periods.
 - v. Supporting each other through periods of ill-health.
 - vi. Practising in different postures in busy periods to change muscle activity and potentially increase the time to fatigue.
 - vii. Learning to recognize signs of fatigue and stopping before overstrain or non-ideal technical compensations occur.
 - viii. Understanding appropriate injury management strategies
2. Education programs that highlight positive health cultures and proactive and early detection and management of injuries in musicians should be provided for all musicians and orchestral staff.

General health

The Sound Practice project identified that many musicians with a variety of health issues did not seek proper medical or health professional advice. In addition, appropriate advice is more likely to be received from health practitioners experienced with the health and work of orchestral musicians. Getting an accurate diagnosis and early injury management will result in most injuries resolving far more quickly.

3. Efforts should be made to have injury advisory sessions by appropriately experienced health professional (medical doctor, physiotherapist) made available for musicians to provide advice on the best management for playing related issues. This would be expected to include evaluation of the musician with the instrument.

Psychological well-being

4. Promotion of psychological well-being within the orchestral workplace needs more attention. This can be facilitated through:
 - a. Psycho-education, which informs musicians about the effects of stress (including the symptoms of panic) and anxiety on their capacity to perform; how to manage their stress and anxiety; and how to recognize when their stress and anxiety is severe enough to warrant referral to a psychologist.
 - b. Provision of confidential psychological support from qualified psychologists and psychotherapists to assist musicians whose music performance anxiety and other psychological issues (e.g., depression, social anxiety, over-use of substances) has proven resistant to psycho-education
 - c. Recognition by management that the young female musicians (<30 years) are the most vulnerable group of musicians in terms of psychological issues by providing newcomers with mentors and other support if needed.
 - d. Addressing bullying at multiple levels of the organization, including management, conductors, section leaders and musicians. Bullying policies need to be developed and enacted.
 - e. Encouragement of physiotherapists to undertake a simple psychological triage assessment when musicians are referred for management of PRMDs, to ensure they identify concomitant psychological issues. Physiotherapists could administer the *Kenny Music Performance Anxiety Inventory* and the PRIME-ED (depression screen). Scores over 105 on the K-MPAI and 'yes' answers to either of the depression questions should trigger a referral to a psychologist for an assessment.
 - f. Orchestras need to address the situational triggers that exacerbate psychological vulnerabilities in musicians.
5. A medical doctor or clinical psychologist should undertake careful assessment of (i) any musicians reporting chronic or significant playing- related health issues that do not respond to physical treatment and (ii) any musicians identified with music performance anxiety. These musicians need to be directed to appropriate psychological interventions.

Hearing health

It is well established that orchestral musicians may be exposed to levels of sound that risk permanent damage to their hearing. There needs to be an integrated and comprehensive approach to prevention of noise-induced hearing loss, based on available evidence.

6. Ongoing education and training of all musicians and orchestral staff, and comprehensive induction of new staff, in regards to hearing conservation is required. This should include:
 - a. Induction training on hearing conservation practices
 - b. Regular (annual) training in hearing conservation
 - c. Monitoring noise exposure regularly (including during personal practice)
 - d. Quiet break and warm-up policies

7. All orchestras should have ongoing sound and audiology monitoring programs in place:
 - a. Monitoring programs should be supported by practices which use the data gathered to implement considered, effective control measures and to provide the basis for adequate education and training for the musicians and their operational staff
 - b. Controls should be implemented according to a hierarchy, with personal controls mandated in addition and subsequent to the implementation of all other available controls able to be implemented in a reasonably practicable manner. For example, set-ups that may assist in the reduction of noise issues, such as the use of risers and distance between players, should be considered; loud instruments being under pit overhangs should be avoided if possible; noise rostering should be undertaken.
 - c. Personal controls, including acoustic screens and ear plugs, should be of a quality appropriate to the industry
 - d. Risks, expectations and obligations in regards to hearing conservation should be clearly communicated to the musicians and orchestral staff on a program-by-program basis
 - e. Annual hearing testing for musicians should be mandatory
 - f. Clear processes for managing noise complaints/hearing injuries should be established

Injury prevention and management

Physical assessments conducted in this study confirm that musicians are functioning at a very high level of physical function. Any dysfunction in terms of elite performance may not be detected using standard clinical tests, and suitably experienced health professionals should assess musicians, preferably also with their instrument. In addition, identifying and modifying factors that may increase the risk to musicians' health should be regularly performed.

8. Ongoing monitoring and evaluation of orchestral injury risks should include trying to reduce barriers towards reporting factors that may have influenced development of ill-health. Use of the surveillance system (www.musicianwellnessproject.com) may facilitate this process.
9. Injury surveillance allows ongoing identification of risk factors for health and well-being of orchestral musicians. Recommendations in this regards are:
 - a. Formal trial of the orchestral surveillance tool—available at www.musicianwellnessproject.com
 - b. Establishment of formal procedures to operate the system and use the data under the auspices of a Musician Health Committee.

10. Injury management

Awareness of the need for best practice management of injuries with professional musician needs to include:

- a. Encouragement of early reporting

- b. Establishment of an early management policy for health issues according to WHS guidelines, including consultation with rehabilitation providers
- c. Establishment of a protocol for formal arrangements with health professionals (General Practitioner, physiotherapist, audiologist, psychologist) experienced with the health and work of orchestral musicians.

Physical preparedness

The phenomenon of the musical athlete needs to be acknowledged and embraced by musicians, management and health professionals to provide a comprehensive and specific fitness and wellness guide. Improving strength of supporting muscles and participating in techniques that ease muscle tension appear to be beneficial to musicians. This study suggests the following should be included to improve musician health in this regard:

- 11. Encourage interventions that increase strength and balance of supporting muscles, such as those in the trunk neck and shoulder , but do not overload muscles already used extensively during playing (e.g.: hand, elbow, face muscles).
- 12. Techniques that help reduce tension in the arms during playing. These could include video feedback sessions
- 13. Cardiovascular fitness for general increased physical energy and improved mental health. Activities such as powerwalking or cycling, and swimming using a variety of strokes (e.g. including backstroke), will help to ensure that overworked musculature are not inappropriately loaded.
- 14. Return to work programs that include finding appropriate workplace roles as a staging process to maintain social contact for injured musicians and prevent or ease personal identity crises associated with an inability to play.

Work health and safety

This study has identified some areas that can be improved in relation to WHS.

- 15. Health education needs to be a regular and ongoing part of WHS strategies within orchestras
- 16. Orchestras should establish a small group made up of key internal stakeholders with the responsibility to manage, implement and audit hearing conservation strategies. A group that similarly oversees strategies to optimise the physical, general and psychological health of musicians would be beneficial.
- 17. Risks should be identified and modification strategies implemented wherever possible when any WHS incidents occur.
- 18. Extra training for orchestra administrative staff in managing potentially distressed musicians reporting health issues may be useful to facilitate injury reporting processes.

Health professionals

Other domains of elite performance routinely have suitably qualified health professionals providing specialized health services. While Sound Practice trained a team of physiotherapists as part of the study, more training needs to occur in this domain also in the medical and psychological healthcare domains. Relevant strategies supported or encouraged by orchestras could usefully include:

19. Education of health professionals treating musicians on the elite performance requirements of professional musicians.
20. Development of formalised musician health training programs for healthcare practitioners.
21. Treatment providers providing some evidence of experience working with musicians, and ensuring musicians are rehabilitated fully into playing demands before returning to work.

CHAPTER 1 – INTRODUCTION

1.1 The Sound Practice Project overview

The performing arts, including orchestral and ensemble music, enriches Australia's cultural life and build its image as an innovative, sophisticated nation. The commercial success of Australia's eight major professional orchestras is due to the outstanding standard of performance achieved by its musicians. This success relies on musicians' optimal performance capabilities both physically and mentally.

This study answered the call from the government-commissioned Strong Report (2005) for the development and implementation of the first-ever national occupational health and safety policies and practices for orchestral musicians.

Baseline evaluation provided a national database of the physical characteristics of musicians that allowed targeted injury prevention initiatives to be implemented.

Innovative interventions to improve musicians' health included specific exercise programs, a national hearing review, biomechanical performance, embouchure and breathing muscle activity assessment and Alexander lesson participation. Education programs were regularly run on topics including music performance anxiety management, hearing conservation, injury prevention and management strategies.

The results of these evaluations and interventions will provide the foundations for ongoing occupational health and safety guidelines to use best evidence to prevent injuries and effectively manage injured musicians in this industry. These guidelines will be the world first attempt to form a benchmark for this industry that will have relevance both nationally and internationally.

The rise in insurance premiums in Australia's eight professional orchestras from \$0.5 million in 2001 to \$1.5 million in 2004 (Strong, 2005) highlights the extent and rising trajectory of compensable performance related injuries in instrumental musicians. Orchestras have attempted to address these concerns through the provision of various interventions and practices. However, the absence of systematic collection of long-term, prospective injury surveillance data has precluded the identification of the most important risk factors and the most effective interventions for orchestral musicians.

The final conclusion of the Strong Report, 2005, was:

“...the management of occupational health and safety is now an important issue for orchestras world-wide, and there is reason to believe that the practices used by some Australian orchestras could be significantly improved.”

p.45 James Strong (2005) A New Era- Orchestras Review Report

A unique opportunity arose for collaborative research between Australia’s premier state orchestras and a team of internationally recognised researchers in the fields of occupational and music medicine from The University of Sydney to address the challenge posed by the Strong report. A comprehensive study on professional orchestras work health and safety injuries and the development of better injury management practices was designed.

In October 2008, the Australian Research Council awarded \$735,000 to the project. The industry partner The Australia Council of the Arts awarded \$500,000 and the eight professional orchestras supplemented this figure. Funding commenced in August 2009 for five years.

Major knowledge gaps were identified in;

- Physical and psychological characteristics of professional orchestra musicians,
- Efficacy of evidence based injury management and prevention techniques within this population,
- Understanding the risks of injury or ill-health from various factors, both intrinsic and extrinsic, that orchestra musicians are exposed to.

The aim of this project was to gather a comprehensive range of health information through a series of baseline investigations that would be used to develop interventional research studies. The results have been used to develop relevant and specific occupational health and safety recommendations for orchestral musicians.

1.2 The Research Team

The research team assembled to undertake this project was unique, with highly specialised researchers bringing together skills from multiple health disciplines. This is unusual and difficult to replicate internationally at this time. This diverse and expert skill set was necessary to be able to address this highly complex field of orchestral musicians' occupational health in Australia.

The collaborative team from The University of Sydney comprised:

Dr Bronwen Ackermann PhD, physiotherapist, inaugural president of the Australian Society for Performing Arts Healthcare (www.aspah.org.au) and chair of international liaison and education for the Performing Arts Medicine Association (USA). She has worked clinically with musicians for 20 years and has close links with many Australian orchestras. She is a senior lecturer in functional musculoskeletal anatomy at the Sydney Medical School at the University of Sydney and a well-known researcher in the field of musicians' health.

Professor Dianna Kenny PhD, is Professor of Psychology and Professor of Music, Faculty of Arts and Social Sciences, University of Sydney. Dianna has a national reputation for her research in injury management systems, which resulted in changes to Workers' Compensation legislation in NSW and is internationally recognized for her ground-breaking work in the field of music performance anxiety. She is the author of *The Psychology of Music Performance Anxiety* (OUP, 2011).

Professor Tim Driscoll MBBS, PhD, occupational physician and epidemiologist, specializes in the prevention of injury in the workplace and is a public health consultant and Professor in the School of Public Health at the University of Sydney.

Several post-graduate students were involved in the project, including an audiologist (Ian O'Brien) and physiotherapist (Cliffon Chan) who completed their PhD degrees as part of this project. Several students also worked on aspects of this project, including Dale Rickert (PhD- psychosocial factors affecting musicians' health and right shoulder injuries in cellists), J. Matt McCrary (PhD - Effects of muscle fatigue, pain and warm-up on elite performance), Phillip Stuckey (Honours Physiotherapy – respiratory muscle activity and posture) and Gemma Jacklyn (MPH – physical comparisons between instrumentalists).

The team also comprised allied health practitioners including audiologists, exercise physiologists, massage therapists and physiotherapists who were contracted to conduct the relevant targeted interventions. In addition, a teacher of Alexander Technique was involved in one intervention trial.

1.3 The Partner Organisations

The participating Orchestras representing the Eight Principal Orchestras of Australia included:

Adelaide Symphony Orchestra (ASO)
Australian Opera and Ballet Orchestra (AOBO)
Melbourne Symphony Orchestra (MSO)
Orchestra Victoria (OV)
Queensland Symphony Orchestra (QSO)
Sydney Symphony Orchestra (SSO)
Tasmanian Symphony Orchestra (TSO)
West Australia Symphony Orchestra (WASO)

The CEOs, orchestra managers and human resources personnel from each of the eight participating orchestras indicated their main concerns and the OHS areas that needed to be addressed in their respective orchestras.

Each of the eight participating Principal Orchestras of Australia nominated a CEO and Liaison Officer to act as initial contact within their respective orchestras, with the Sound Practice Project authors. Liaison officers within each orchestra arranged participant recruitment, scheduling and coordination of the onsite intervention trials.

Regular Liaison Officer Group Meetings and CEO Updates were undertaken (Appendix 7).

The use of orchestra premises as the site of most interventions constitutes an additional major 'in kind' contribution to the project. The participation rates for intervention and injury management trials were improved with continued local orchestra management support.

1.4 Project Goals

This project provided a unique opportunity to work with the professional orchestras in developing the best possible workplace conditions in terms of occupational health and safety initiatives aimed at ensuring long-term sustainability of the careers of orchestral musicians. The aims of this collaboration fit naturally into the strategic aims of the Australian Council of the Arts

and the orchestras, a major objective of which was to encourage collaborations between creative practitioners and scientists through the ARC Linkage Grant Scheme.

The study design of the Sound Practice Project made, for the first time, analysis of complex causative, moderating and mediating influences on musician injuries.

The six key innovations arising from the project were:

- (i) Development of the first national injury surveillance system for orchestral musicians internationally
- (ii) Implementation of the first evidence-based systematic approach to injury prevention and management that provides a blue print for WHS procedures in the classical music industry.
- (iii) Development of national WHS guidelines for all professional Australian orchestral musicians.
- (iv) Journal articles on injury prevention and treatment of common injuries in musicians that can be accessed by other health practitioners working in this sector.
- (v) Creation of effective strategies for injury prevention and education of orchestral musicians.
- (vi) Establishment of the best WHS practices through an interdisciplinary approach to address physical, physiological, psychological, ergonomic and audiological factors.

SECTION ONE: BASIC FINDINGS

CHAPTER 2- DEMOGRAPHIC CHARACTERISTICS AND GENERAL HEALTH OF ORCHESTRAL MUSICIANS

KEY FINDINGS

1. Overall, musicians drink less, smoke less and are less overweight than the average Australian population.
2. However, a small percentage of musicians drink alcohol at a dangerous level according to Australian Government guidelines.
3. Musicians perceived overplaying to be a key cause of injuries, along with muscle fatigue and muscle tension.
4. Posture, poor injury management, stress and anxiety are other significant factors that musicians report are likely to increase the risk of injury.

2.1 Introduction

To determine the physical characteristics and general health profiles of professional orchestral musicians in the first stage of the Sound Practice Project, a detailed questionnaire and physical assessment protocol was developed and administered nationally to participating orchestral musicians. The measurement approaches and instruments developed for this baseline study should prove beneficial in the future to researchers working with professional musicians, used in their current format or as a basis for new measurement instruments.

The questions covering **physical aspects** were divided into three main sections.

Section One covered demographics and general exercise/activity levels.

Section Two covered playing and performance, including: the instrument type; experience playing the instrument(s); typical practice, rehearsal, and performance workloads (covering both the time spent and the activity); physical and psychological stressors; and ratings of perceived exertion associated with the various activities.

Section Three covered pain and injury associated with playing. This included current pain or injury; previous history of pain or injury; factors perceived by the respondent to have contributed to the pain or injury; pain or injury management strategies that had been employed and their perceived effectiveness; health personnel involved in pain or injury management and their perceived effectiveness; dystonic symptoms; and questions based on the QuickDash questionnaire to assess upper limb strength and function. Results for this are covered later.

2.2 Participants

Three hundred and seventy-seven musicians from the eight professional symphony orchestras in Australia took part in this initial baseline cross-sectional data collection at the beginning of the project. This represented about 70% of eligible musicians.

From the initial baseline information a general profile of the professional orchestral musicians of Australia was developed. Throughout the duration of the 5-year project, all orchestral musicians were able to participate in interventions or other surveys regardless of participation in the initial baseline component.

Age ranges varied (Table 1) as did **years of playing** (Table 2).

Table 1 Age ranges of participating musicians

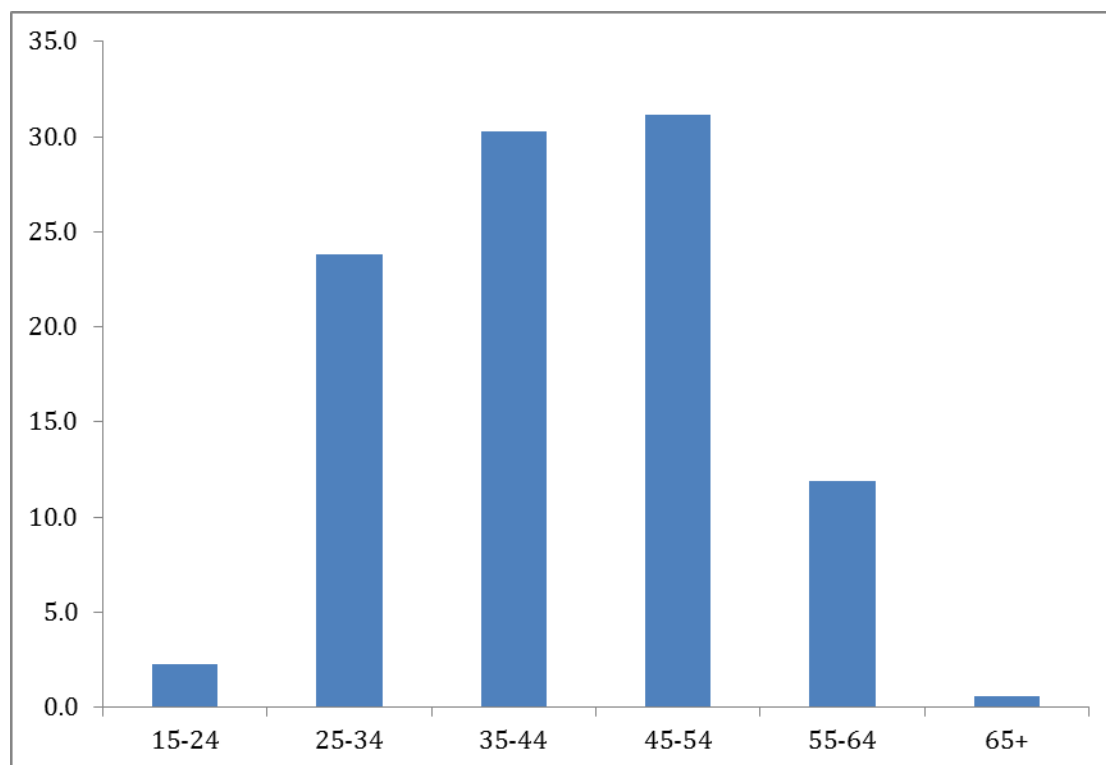
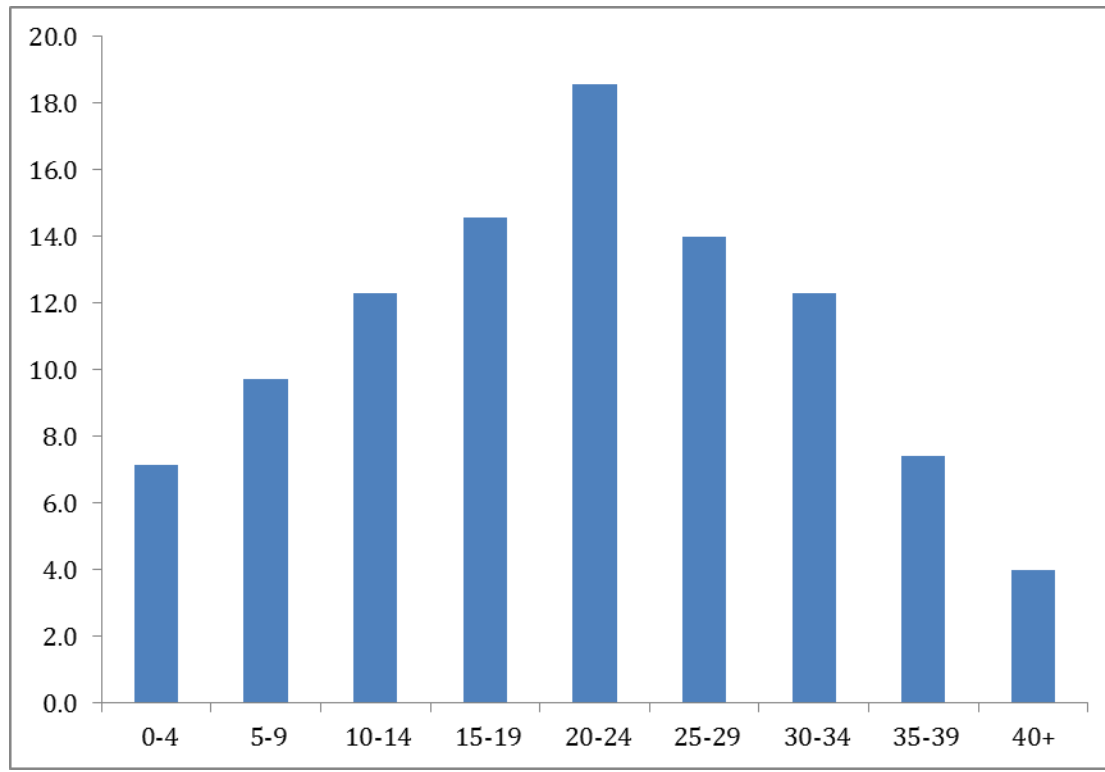


Table 2 Years of professional playing



The most **common instrument group** was upper strings (violin and viola – 45%), with most of the remainder fairly evenly spread between lower strings, woodwind and brass. There were clear differences in many strength and flexibility measurements between males and females, but not between different age groups. (Table 3)

Table 3 Instrument groups played

Instrument	Males		Females		Total ¹	
	n	%	n	%	n	%
Upper strings						
Violin	43	21.6	84	40.8	127	31.4
Viola	21	10.6	34	16.5	55	13.6
Total	64	31.2	118	47.3	182	44.9
Lower strings						
Cello	25	12.6	23	11.2	48	11.9
Double Bass	17	8.5	9	4.4	26	6.4
Total	42	21.1	32	15.6	74	18.3
Woodwind						
Flute	6	3.0	16	7.8	22	5.4
Oboe	9	4.5	9	4.4	18	4.4
Bassoon	8	4.0	9	4.4	17	4.2
Clarinet	12	6.0	2	1.0	14	3.5
Total	35	17.5	36	17.6	71	17.5
Brass						
French horn	16	8.0	12	5.8	28	6.9
Trombone	16	8.0	1	0.5	17	4.2
Trumpet	11	5.5	1	0.5	12	3.0
Tuba	4	2.0	0	-	4	1.0
Total	47	23.5	14	6.8	61	15.1
Percussion and tympani						
Percussion	6	3.0	1	0.5	7	
Tympani	5	2.5	1	0.5	6	
Total	11	5.5	2	1.0	13	3.2
Other						
Harp	0	-	4	1.9	4	
Total			4	1.9	4	1.0
Total	199	100.0	206	100.0	408	100.0

1: Sex was missing for three musicians

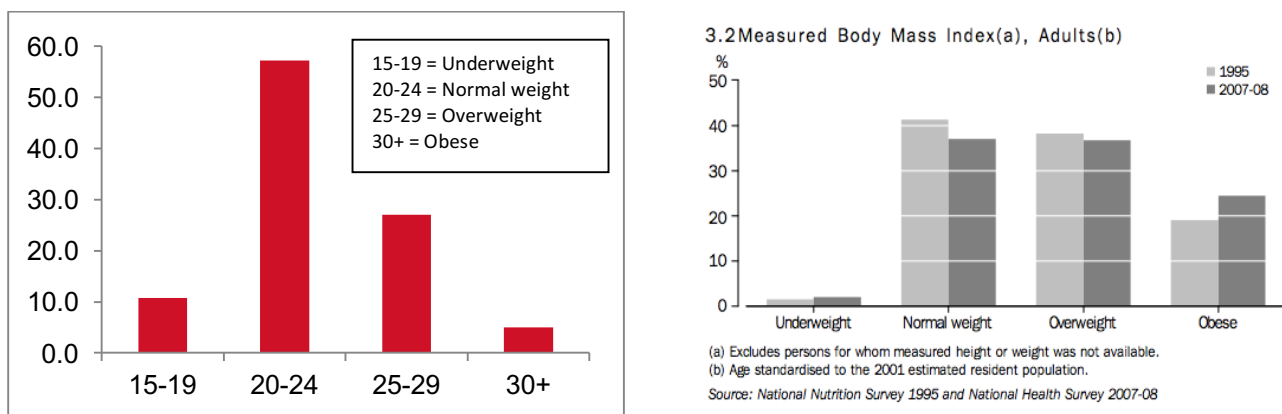
(from: Driscoll, T., Ackermann, B. (2012). Applied musculoskeletal assessment: Results from a standardized physical assessment in a national population of professional orchestral musicians. *Rheumatology* S2:005)

2.3 Results

2.3.1. BMI

BMI refers to body mass index, which is a useful guide to help adults determine whether they are in a healthy weight range, underweight or overweight. It is calculated using the equation $\text{weight (kg)}/\text{height(m)}^2$. The results below indicate that 70% musicians (shown in the left side of figure 1) fall in the normal weight category, and 30% in the overweight to obese category. This suggests that orchestral musicians are less overweight than the general Australian population¹ (shown in the right side of figure 1).

Figure 1: BMI



2.3.2. Smoking

68.9% of musicians had never smoked and only 5.9% of orchestral musicians were current smokers. Musicians therefore had lower rates of smoking than the Australian population (16.3% Australians over 18 who smoked daily)*

* Australian Health Survey 2011-2012, Australian Bureau statistics

www.abs.gov.au/ausstats/abs@.nsf/lookup/73963BA1EA6D6221CA257AA30014BE3E?opendocument

¹ From [http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/7DC7186F4A9950DECA25789C0023DCEF/\\$File/4842055001_200708.pdf](http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/7DC7186F4A9950DECA25789C0023DCEF/$File/4842055001_200708.pdf)

2.3.3. Alcohol

70% of musicians reported drinking fewer than 7 standard drinks per week and 70% of musicians reported drinking 1-2 standard drinks at any drinking episode, which is within recommended guidelines. However approximately 30% of musicians appeared to be drinking at a level deemed “risky” based on Australian guidelines.

In the orchestral musician sample 14.5% (n=49) had drunk more than 14 standard drinks in the previous seven days. A further 8.3% (n=28) drank between 11-12 drinks in the past seven days.

Guideline 1 of the NHMRC alcohol guidelines, 2009*, states that “drinking less frequently over a lifetime (e.g. weekly rather than daily drinking) and drinking less on each drinking occasion, reduces the lifetime risk of alcohol related harm”.

In the orchestral musician sample 5% (n=17) reported drinking every day; a further 26.5% (n=89) drank on five to six days a week.

Guideline 2 of the NHMRC alcohol guidelines, 2009*, states that “on a single occasion of drinking, the risk of alcohol-related injury increases with the amount of alcohol consumed. For healthy men and women, drinking no more than four standard drinks on any one occasion reduces the risk of alcohol-related injury arising from that occasion.

In the orchestral musician sample 7% (n=23) drank more than five standard drinks on any one occasion of drinking.

* NHMRC Alcohol guidelines, 2009, www.nhmrc.gov.au/files/nhmrc/publications/attachments/ds10-alcohol.pdf

2.3.4 Perceived injury causes

Musicians were asked at the outset of the study to indicate the factors that they were exposed to that they felt increased their risk of suffering a performance-related musculoskeletal disorder. Results are shown in % in the figure below.

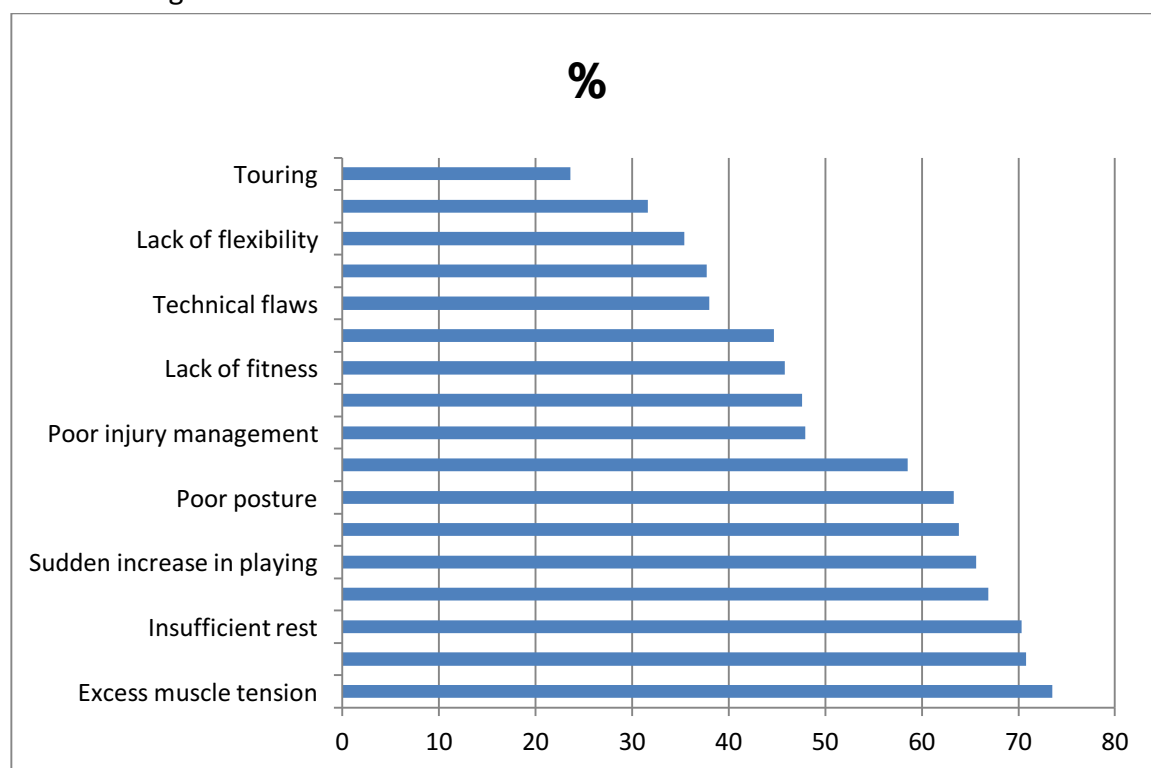


Figure 2: Perceived injury risk factors from least at the top to greatest at the bottom

2.4 Conclusions

The demographic and playing profile of participating orchestral musicians showed a good representation of experience, age, gender and instrumental groups. Low frequency instruments, for example, harpists (4 females) and tubists (4 males), was expected given the relatively small number of these instrumentalists working as full-time professionals in this group of orchestras. Body weight, as represented by BMI, was better than the Australian average. While overall the levels of alcohol consumption were comparable with the Australian population, 30% were consuming alcohol at levels deemed risky by current Australian health guidelines. Musicians clearly perceive overload to be a major source of their musculoskeletal issues with sudden playing increases, lack of rest, muscle fatigue and tension rating highly as likely injury causative factors.

CHAPTER 3: PHYSICAL CHARACTERISTICS OF ORCHESTRAL MUSICIANS

Key Findings

1. Musicians were either average or above average in strength and flexibility measures using standard testing procedures for physical examination
2. Differences in musculoskeletal profiles between certain instrumental groups were identified
3. Performance-related musculoskeletal disorders may not be identified in standard clinical shoulder physical examination protocols. These may be affected by posture and dynamic physical movement required to play instruments, which are not typical evaluation procedures
4. Adaptive musculoskeletal changes are seen in response to playing demands
5. Facial muscle activation patterns to form an embouchure varied widely between musicians playing different wind and brass instruments
6. Specific levels of muscle activation were high (~40% of the maximum muscle contraction) in certain muscles in various muscle testing performed, e.g. in the face muscles of wind and brass players, and one of the shoulder rotator cuff muscle in cellists. Occupational health literature suggests 12-14% of maximum muscle activity is safest for 8 hours of intermittent workload
7. Breathing musculature is activated more in standing compared with sitting postures

3.1 Introduction

The physical component of the Sound Practice project involved a baseline examination followed by a series of trial interventions. The baseline examinations aimed to provide a detailed understanding of the current physical health of musicians and allow development of a musculoskeletal profile of orchestral musicians. It also aimed to identify any important physical health issues. This information was used as the basis of targeted interventions to promote the implementation of effective injury management or prevention protocols.

3.2 Primary Stage Assessments

The assessment aimed to cover the main parts of the body reported to be prone to sustaining musculoskeletal injuries in the musician population. The examination was based on evidence based practice focused on the upper limb but also covered the neck, upper and lower back, trunk, and, to a lesser extent, the lower limbs. The assessment covered range of movement, dexterity, and strength. There was a focus on fine motor work and gross motor upper limb activities. Eighteen physiotherapists, with an average clinical experience of 15 years, attended training and were involved in the assessments.

The results from this musculoskeletal assessment of a large group of professional orchestral musicians gave normative data against which can be used for comparison in other orchestras and settings.

The physical examination testing procedures revealed that using standard clinical protocols, musicians were either normal or above normal in measurements, despite the 50% presence of pain or injuries. This indicates that using standard clinical measurement tools may be inadequate to fully evaluate musicians' physical health issues. Clearly elite performance involves high-level physical skills that may be beyond the capacity of typical current clinical tests designed to detect more major musculoskeletal defects.

The results clearly show differences in musculoskeletal profiles of certain instrumental groups. This included:

- Grip strength significantly related to instrument group - highest in brass players and lowest in string players ($F_{4, 390} = 2.18$, $p=0.019$ for left hand).
- Left hand span significantly related to instrument group – lower strings greatest left span, woodwind smallest ($F_{4, 391} = 3.92$, $p<0.004$).
- Left arm supination significantly related to instrument group – upper strings highest and brass/percussion lowest ($F_{4, 384}=3.92$, $p<0.004$).*

*Driscoll, T. and Ackermann, B. Applied musculoskeletal assessment: Results from a standardized physical assessment in a national population of professional orchestral musicians. *Rheumatology: Current Research "Musculoskeletal Examination Special Edition"* May 2012.

3.3 Secondary Stage Assessments

In response to this, further more detailed assessments were conducted. This included: characterising facial and respiratory muscle activation patterns in wind and brass instrumentalists; muscle activation patterns pre and post warm up (Chapter 5); triage advice and assessment by physiotherapists and the use of video feedback for biomechanical review of performance (Chapter 6).

Electromyography investigations of muscle activity levels

Electromyography (EMG) uses electrodes to measure the timing, frequency and intensity of nerve impulses occurring in muscles. This lets us know which muscles are working, when they are working and how hard they are working.

3.3.1 Electromyography investigation of right shoulder muscle activity in a cellist

A pilot study was conducted investigating the patterns of right shoulder muscles during cello playing. This study was prompted by the initial finding of increased rates of performance-related musculoskeletal disorders occurring in the right shoulders of cellists. In this study, a cellist from one of the participating symphony orchestras performed a wide range of typical cello repertoire whilst electrodes, both inserted into the muscle and on the surface, were used to gather information in relation to muscle activity.

Results indicated that supraspinatus, a muscle commonly implicated in rotator cuff disorders of the shoulder, was under intermittent extremely high levels of activations whilst playing. These levels were worse with playing with the arm at its highest and furthest reach (i.e. at the tip of the bow on the A string) where the supraspinatus muscle activity levels reached up to 60% of maximum possible activation. This implies that pieces involving relatively frequent bowing in higher arm elevations may need to be practiced in shorted durations to reduce the risk of muscle overload and subsequent injury.

3.3.2 Facial muscle activity during performance in wind and brass players

This study, which used surface electromyography, showed distinctly different patterns of facial muscle activity occurring between different wind and brass players to form an embouchure, and the levels of activity may vary markedly between pieces played. Results demonstrated that in most cases nearly all facial muscle levels of activation were high (up to 40% of maximum muscle activity). This contrasts to typical workplace recommendations where for 8 hours of intermittent work, muscles should be operating below around 12-14% of their maximum activation. There was a fairly constant high load in muscles forming the embouchure in woodwinds, particularly bassoon and oboe, whereas brass instruments had much greater load variability, with up to 70% variation in muscle effort between pieces.

3.3.3 Effect of different postures on respiratory muscle activity

This study evaluated chest and abdominal expansion as well as activation patterns of lower and upper abdominal musculature (breath support muscles), using surface electromyography, during performance of a range of typical orchestral repertoires by 113 woodwind and brass players. These muscles appeared to operate within normal workplace muscle activity boundaries. There were four positions randomly allocated to musicians; standing, sitting, sitting with forward tilt, sitting with backwards tilt. The study results demonstrated and showed more muscle activation was present in standing compared to sitting, potentially meaning there is more 'breath support' in standing. There was no significant difference in muscle activity between the sitting postures, although players preferred not to play in a backward tilt.

3.3.4 Effects of pain on right arm muscle activation patterns in violinists

The purpose of this study was to determine whether the presence of pain may affect muscles used during musical performance. This was carried out on a cohort of 55 violinists, and investigated the right arm muscle activity during bowing. Of the 55 violinists tested, 56% had some form of performance-related pain. The main findings included:

- (i) a global increase in right arm muscle activity in the presence of right wrist pain.
- (ii) an alteration in muscle activity patterns with right shoulder pain – specifically that there appeared to be less activity in shoulder blade stabilising muscles, and more in the arm muscles.

While cause or effect cannot be determined, this provides a useful corrective guide for rehabilitation. Implications are that restoring scapulohumeral rhythm and proximal to distal flow of action is critical.

3.4. Chapter Summary

1. Musicians need to be aware of the varying demands of repertoire and take measures to moderate diet or practice duration to try to avoid playing past muscle fatigue. These measures may include:
 - a. Warm-up activities in pre- performance routine
 - b. Adapting practice session duration and dietary supplementation according to the demands of the repertoire played
 - c. Carefully plan external activities (including teaching) to manage orchestral demands.
2. Muscle activity levels change in sitting compared to standing – this could provide a useful way of managing load. For example, practice in standing when not in the orchestral workplace.
3. The presence of performance-related injuries can alter muscle activity patterns, reinforcing the need for addressing and managing injuries early and properly.

3.5 Published papers

1. Driscoll, T., Ackermann, B. (2012). Applied musculoskeletal assessment: Results from a standardized physical assessment in a national population of professional orchestral musicians. *Rheumatology* S2:005)
2. Rickert, D. L., Halaki, M., Ginn, K. A., Barrett, M. S., & Ackermann, B. J. (2013). The use of fine-wire EMG to investigate shoulder muscle recruitment patterns during cello bowing: The results of a pilot study. *Journal of Electromyography and Kinesiology*, 23(6), 1261-1268.
3. Ackermann, B., O'Dwyer, N., Halaki, M. (final draft preparation for submission) Facial muscle activity demands during performance in wind and brass musicians
4. Ackermann, B., O'Dwyer, N., Halaki, M. (2014). The difference between standing and sitting in three different seat inclinations on abdominal muscle activity and chest and abdominal expansion in woodwind and brass musicians. *Frontiers in Psychology*, (5), 1-9.
5. McCrary, J. M., Halaki, M., & Ackermann, B. J. (2016). Effects of Physical Symptoms on Muscle Activity Levels in Skilled Violinists. *Medical problems of performing artists*, 31(3), 125.

CHAPTER 4 PAIN AND PERFORMANCE RELATED MUSCULOSKELETAL DISORDERS (PRMDs)

Key Findings

1. Pain is a common problem for orchestral musicians
2. 84% of musicians have experienced pain or injuries that had interfered with playing rehearsals in the previous 18 months;
3. 50% of musicians reported having current pain or injury, of which more than half of these had been present for 3 months or longer 28% of musicians had taken at least 1 day off from work for such pain in the previous 18 months
4. The most commonly reported performance-related factors that had contributed to injury or pain included:
 - a. Excess muscle tension
 - b. Muscle fatigue
 - c. Insufficient rest, and
 - d. Long practice sessions

4.1 Introduction

The definition of **Performance-related musculoskeletal disorders (PRMDs)** that was used throughout the research and within this report is defined as “any pain, weakness, numbness, tingling or other physical symptoms that interfere with your ability to play your instrument at the level to which you are accustomed” which was based on previous research studies. This definition has been reported to indicate the typical range of physical conditions that professional orchestral musicians may suffer from related to playing their instrument.

4.2 PRMD rates

The Sound Practice survey revealed high injury rates with:

- 84% of musicians interviewed having experienced pain or injuries that had interfered either with playing their instrument or participating in normal orchestral rehearsals and performances in the preceding 18-month period.
- 49% of musicians reported having current pain or injury, which had lasted more than a week at the time of the survey, mostly with disorders perceived by the musicians to be work-related.
- 28% of musicians had taken at least 1 day off from work for such pain in the previous 18 months.

These figures are consistent with orchestral musician PRMD reports emerging from the USA, UK, Germany and Scandinavia, which highlights the urgent need for international efforts to rectify this situation.

4.3 Work outside the orchestra and PRMD risk

32% (120) of the musicians indicated that in a typical week they would undertake at least some non-orchestra playing “outside” work, either in a chamber ensemble or for a commercial gig.

Musicians performing some outside calls, but less than 4 outside calls per week, did not have an increased likelihood of reporting current pain or injury compared to persons performing no outside calls per week. These results were not significantly altered when instrument type, total number of calls per week, age, or gender were taken into account.

Twenty-six musicians reported performing 4 or more outside calls in a typical week in addition to their orchestra work. These 26 musicians were three times more likely to report that they had pain or injury at the time of the survey, compared to musicians who had less than four outside calls per week. The low number of subjects and injuries involved makes the significance of this finding uncertain, especially given that there was no apparent relationship between the likelihood of reporting of current pain or injury and the total number of calls per week for musicians overall. However, this suggests that care should be taken with the total musician workload in order to minimize the risk of injury.

4.4 Most commonly affected PRMD sites

The most common sites affected were the trunk (primarily the back), the right upper limb and neck, the left upper limb and neck, and the neck alone, but the relative proportions varied by instrument. (Table 4)

Table 4: PRMD by instrument group and body region with participant numbers shown

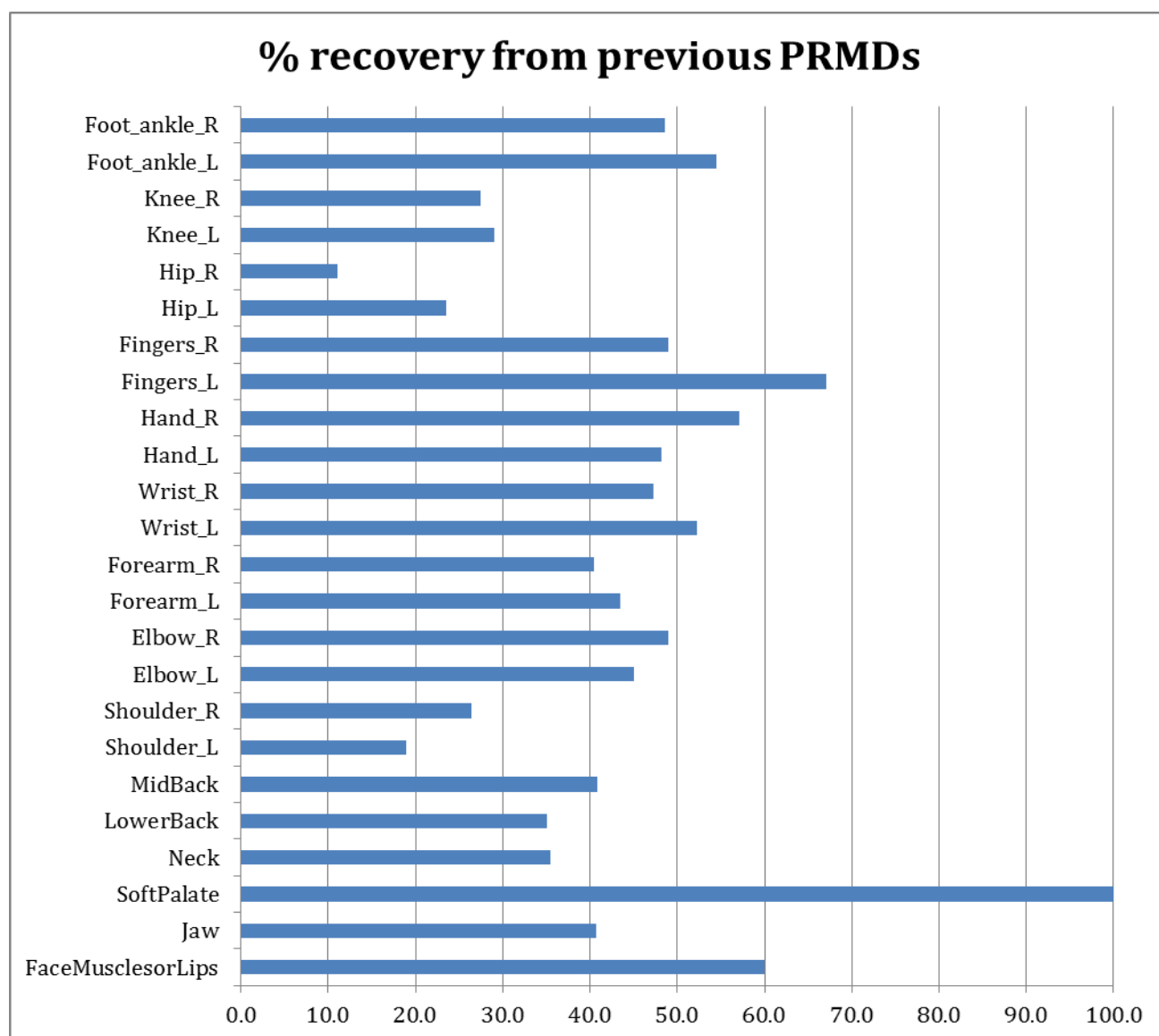
Body region	Brass	Woodwind	Lower strings	Upper strings	Percussion	Total
	N=58	N=67	N=68	N=169	N=12	N=377
Head, face, lips	8.6	4.5	2.9	1.2	0	3.2
Neck	17.2	9.0	16.2	12.4	16.7	13.5
Arm and neck L	15.5	6.0	11.8	18.9	8.3	14.6
Arm and neck R	13.8	29.9	25.0	21.3	25.0	22.3
Trunk*	32.8	17.9	30.9	23.1	16.7	24.9
Total	55.2	49.3	54.4	45.0	50.0	49.6

Injured areas appear to be consistent with body parts most subjected to repetitive or awkward sustained loading created by the particular instrument. Trombonists reported significantly more left shoulder performance-related pain than cellists (50% vs 20%, $p=0.02$), while pain in the right shoulder was greater in cellists than trombonists (46% vs 19%, $p=0.04$).

4.5 Recovery from PRMDs

Only 40% of professional orchestral musicians reported full recovery from previous PRMD conditions. Previous research indicates that prior injuries increase the risk of sustaining future injuries, and it is concerning that the majority of musicians do not fully rehabilitate injuries related to performance prior to returning to performance. (Figure 3)

Figure 3: Percentage (%) Recovery from previous PRMDs



4.6 Chapter Summary

1. The high rate of injury reported by musicians reinforces the need for investigating active strategies to prevent the musician suffering a performance-related injury.
2. Efforts should be made to evaluate the instrument specific demands placed on musicians' body structures as regions affected varied considerably between instrumentalists, and these locations appeared to reinforce the postural and repetitive playing demands particular to that instrument
3. Treatment providers should ensure musicians are rehabilitated fully into playing demands and are completely recovered wherever possible from injuries before returning to work.

4.7 Published Papers

1. Ackermann, B. J., Kenny, D. T., O'Brien, I., & Driscoll, T. R. (2014). Sound Practice—improving occupational health and safety for professional orchestral musicians in Australia. *Frontiers in psychology*, 5.
2. Ackermann, B. J. & Driscoll, T.R. (2010). Development of a new instrument for measuring the musculoskeletal load and physical health of professional orchestral musicians. *Medical Problems of Performing Artists* (25), 95–101.
3. Ackermann, B.J., Driscoll, T.R., & Kenny, D.T. (2012). Musculoskeletal pain and injury in professional orchestral musicians in Australia. *Medical Problems of Performing Artists*, 27 (4), 181-187.

CHAPTER 5: PSYCHOLOGICAL CHARACTERISTICS OF ORCHESTRAL MUSICIANS

Key Findings

1. Female musicians and younger musicians (<30 years) reported significantly higher trait anxiety, music performance anxiety, social anxiety, and other forms of anxiety and depression than male and older (>51 years) musicians
2. 33% of musicians may meet criteria for a diagnosis of social phobia
3. 32% returned a positive depression screen
4. *Kenny Music Performance Anxiety Inventory* (K-MPAI) is a valid and reliable instrument for the assessment of and treatment planning for music performance anxiety
5. The complex area of psychological health in musicians needs to incorporate psychological screening and awareness of the need for vigilance by health practitioners in detecting early warning signs of psychological distress, excessive performance anxiety, and depression.

5.1 Introduction

Major findings from the psychosocial baseline questionnaire component comprising a cross-sectional population survey of the sample are presented below.

5.2 Study One: Population study

The first study examined anxiety and depression. Key findings were as follows:

- Female musicians reported significantly higher trait anxiety, music performance anxiety, social anxiety, and other forms of anxiety and depression than male musicians.
- The youngest musicians (<30 years) were significantly more anxious compared with the oldest musicians (51+).
- The youngest female musicians were the group most affected by music performance anxiety. Music performance anxiety was lowest for the older musicians (51+ years).
- Thirty-three per cent (33%) of musicians may have met criteria for a diagnosis of social phobia.
- Twenty-two per cent (22%) answered in the affirmative to a question screening for post-traumatic stress disorder.
- Thirty-two per cent (32%) returned a positive depression screen; this subgroup had higher scores on all of the anxiety measures.
- Trait anxiety, social phobia, depression and age were the key predictors of music performance anxiety severity.

5.3 Kenny Music Performance Anxiety Inventory (K-MPAI)

The *Kenny Music Performance Anxiety Inventory* (K-MPAI) (Kenny, 2009, 2011) was developed and trialled on this population. Results from the population studies indicated that K-MPAI is a valid and reliable instrument for the assessment of and treatment planning for music performance anxiety. The instrument has now been translated into Cantonese, French, German, Indonesian, Italian, Polish, Portuguese, Persian, Spanish and Slovenian and is being trialled around the world in classical orchestras and student populations in order to develop international norms for the instrument. There have been several replications of the factor structure of the K-MPAI in Spanish and Peruvian musicians.

5.4 Study Two

Cut-off scores for the K-MPAI for clinical purposes were calculated. Scores over 105 on the K-MPAI and 'yes' answers to either of the depression questions should trigger a referral to a psychologist for an assessment. Physiotherapists contracted to orchestras as part of a triage system could administer the *Kenny Music Performance Anxiety Inventory* and the PRIME-ED (depression screen) to identify at risk musicians.

5.5 Study Three: Psychotherapy interventions

Twelve musicians volunteered to participate in a trial of Intensive Short Term Dynamic Psychotherapy (ISTDP). Eight were selected to receive between eight and 12 therapy sessions with an experienced ISTDP practitioner. These eight were selected on the basis of K-MPAI scores=100+ and report of experience of failure of other mental health interventions to relieve their severe music performance anxiety (e.g., CBT, mindfulness and affirmations, yoga etc). Detailed case reports were prepared regarding the outcome of therapy. Three papers have been published and one is in press. The published case report was of a 55-year-old male musician who had suffered from severe music performance anxiety for the entirety of his 30-year career as an orchestral musician. At the end of treatment, he was able to perform with enjoyment and freedom that he had never previously experienced. Careful screening needs to occur to determine suitability for this form of psychological treatment.

5.6 Conclusions

The complex area of psychological health in musicians needs to incorporate psychological screening and awareness of the need for vigilance by health practitioners in detecting early warning signs of psychological distress. Orchestras need to address the situational triggers that exacerbate psychological vulnerabilities in musicians. These include how feedback is provided to musicians by conductors, section leaders and management, zero tolerance policy with respect to bullying, provision of a caring and supportive work environment and clear expectations in WHS policies with respect to work safety – both physical and psychological.

Formal induction processes that include a psychological self-management component should be designed to:

- a. Achieve optimal performance.
- b. Educate about and encourage the use of stress management techniques.
- c. Increase understanding of the relationship between physical and psychological well-being.
- d. Recognise and manage sympathetic nervous system arousal sensitivity, which may be a precursor of panic.
- e. Recognise and manage symptoms of panic.
- f. Understand the nature of music performance anxiety and recognize when psychological assistance would be beneficial.
- g. Provide education about the use of beta-blockers and other substances to manage performance anxiety and psychological distress in performance.

Formal provision of a mentoring program is recommended in which newer, younger musicians are appointed an older, more experienced musician as mentors to:

- a) provide confidential advice, and
- b) support musicians struggling under the strain of performance anxiety, performance-related musculoskeletal disorders (PRMDs) and other stresses in their workplace.

In particular, the group identified as most vulnerable, young women, are likely to benefit from both psycho-education and mentoring, and in serious cases, psychological intervention.

5.7 Chapter Summary

Promotion of psychological well-being can be facilitated through:

1. Creation of a formal induction process for new members of the orchestra
2. Provision of confidential psychological support from qualified psychologists and psychotherapists to assist musicians whose music performance anxiety has proved resistant to psycho-education
3. Development of a mentoring program
4. Recognition by management that the young female musicians are the most vulnerable group of musicians
5. Implementation of a simple triage system when musicians are referred to physiotherapists for management of PRMDs to identify concomitant psychological issues

5.8 Published papers

1. Kenny D.T. (2011). *The Psychology of Music Performance Anxiety*. Oxford: Oxford University Press.

2. Kenny, D.T., Driscoll, T., & Ackermann, B. (2014). Psychological well-being in professional orchestral musicians in Australia: A descriptive population study. *Psychology of Music*, 42(2), 210-232.
3. Kenny, D.T. (Technical paper). Identifying cut-off scores for clinical purposes for the *Kenny Music Performance Anxiety Inventory* (K-MPAI) in a population of professional orchestral musicians in Australia. https://www.researchgate.net/profile/Dianna_Kenny
4. Kenny, D.T. (in review). Short-term psychodynamic psychotherapy for a severely performance anxious musician: A case report. *Psychotherapy*
5. Kenny, D.T. & Ackermann, B. (2014). Optimising physical and psychological health in performing musicians. In Susan Hallam, Ian Cross, Michael Thaut (eds.)(2nd ed.). *Oxford Handbook of Music Psychology*. Oxford: Oxford University Press.
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7. Kenny, D. T. (2014). Music performance anxiety. In W. Thompson & J. G. Golson (Eds.), *Music in the Social and Behavioral Sciences: An Encyclopaedia*. (Vol. 1, pp. 62-66). Thousand Oaks, CA: SAGE Publications, Inc. doi: <http://dx.doi.org/10.4135/9781452283012.n20>.
8. Kenny, D.T. & Holmes, J. (2015). Exploring the attachment narrative of a professional musician with severe performance anxiety: A case study. *Journal of Psychology and Psychotherapy*, 5, 190. doi: 10.4172/2161-0487.1000190.
9. Kenny, D.T. and Ackermann, B. (2015). Optimising physical and psychological health in performing musicians. In S. Hallam, I. Cross, M. Thaut (eds.)(2nd ed.). *Oxford Handbook of Music Psychology*. Oxford: Oxford University Press.
10. Kenny, D.T. (2016). Short-term psychodynamic psychotherapy (STPP) for a severely performance anxious musician: A case report. *Journal of Psychology and Psychotherapy*, 6, 272-282. doi:10.4172/2161-0487.1000272
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13. Kenny, D.T. (2016). *Music performance anxiety. Theory, assessment and treatment*. Saarbrücken, Germany: Lambert Academic Publishing.
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15. Kenny, D.T. (2017, in press). Treating music performance anxiety in the psychotherapy and counselling practice. *Psychotherapy and Counselling Journal of Australia*
16. Chang, A., Kenny, D.T. & Burga, A. (2017, in press). Validation of the *Kenny Music Performance Anxiety Inventory* (K-MPAI): A cross-cultural confirmation of its factorial structure. *Psychology of Music*
17. Kenny, D.T. & Holmes (2017, in press). Attachment quality is associated with music performance anxiety in professional musicians: an exploratory narrative study. *Polish Psychological Bulletin*

CHAPTER 6 – RELATIONSHIPS BETWEEN PHYSICAL & PSYCHOLOGICAL CHARACTERISTICS OF ORCHESTRAL MUSICIANS

Key Findings

1. There may be a complex relationship between depression and performance related musculoskeletal pain severity
2. Further exploration of the relationship between performance related musculoskeletal pain severity and music performance anxiety is needed
3. Highlighted the importance of evaluating psychological well-being in musicians with significant performance related musculoskeletal pain
4. Musicians and orchestral management staff perceived that increased stress may lead to a greater risk of injury in the orchestral environment
5. Psychosocial risks included performance stress and interpersonal relationships, and the combined psychosocial and physical risks included issues related to work organization and lack of control
6. Injury concealment identified as a serious problem within orchestras potentially leading to long-term chronic dysfunction
7. Positive health culture change required within orchestras

6.1 Introduction

The relationships between self-reported frequency and severity of performance related musculoskeletal pain, trigger point pain and depression, social phobia and music performance anxiety were examined in 377 of the Australian professional orchestral musicians.

6.2 Relationship between depression and PRMD severity

A complex relationship was found between depression and performance related musculoskeletal pain severity - in general, the worse the pain severity the worse the depression. However, those musicians with most severe pain did not report high levels of depression, indicating that these musicians may either somaticize psychological distress, or be suffering severe pain from a purely physical cause.

6.3 Relationship between performance anxiety and PRMD severity

There was a strong relationship between performance related musculoskeletal pain severity and music performance anxiety, with higher anxiety levels correlated with higher pain severity scores. Using a physical examination procedure, it was found that trigger point symptoms in female musicians were associated with anxiety in a linear manner (i.e. increased trigger point sensitivity with increased anxiety), although this was not the case for male musicians, with the most anxious males having less sensitive trigger points.

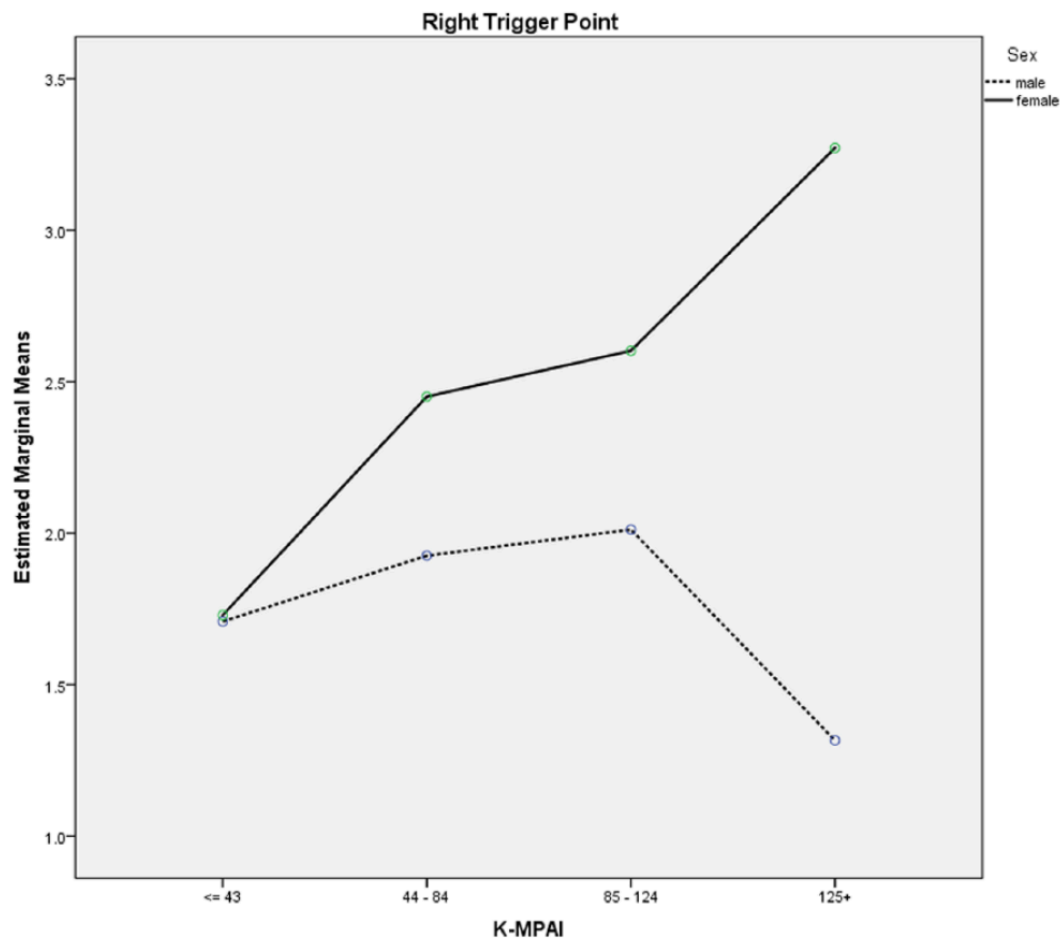


Figure 4: relationship between anxiety and trigger point sensitivity

6.4 Summary of Recommendations

Chapter Summary

1. These findings highlight the importance of evaluating psychological well-being in musicians with significant performance related musculoskeletal pain.
2. Careful screening of musicians reporting chronic PRMDs that do not respond to treatment should be undertaken to assess anxiety, depression or other psychological vulnerability that may benefit from psychological interventions.

6.5 Published Papers

1. Kenny, D.T., & Ackermann, B. (2013). Performance related musculoskeletal pain and depression in professional orchestral musicians. *Psychology of Music*, published online 2 September, DOI:10.1177/0305735613493953
<http://pom.sagepub.com/content/early/2013/09/02/0305735613493953>

CHAPTER 7 – PSYCHOSOCIAL ASPECTS OF INJURY IN THE ORCHESTRA

Key Findings

8. Orchestral musicians feel that there is a stigma associated with injury.
9. There was fear that reporting injury to orchestral management may jeopardise a musicians' career.
10. Perceived lack of health support and awareness may be contributing to poor injury outcomes.
11. Older orchestral musicians can tend to perpetuate the myth that 'playing through pain' is what it takes to be a musician, leading those with problems to feel weak if admitting a problem.
12. Promoting healthy cultures within the orchestral workplace by encouraging a positive and proactive approach to addressing physical and psychological health issues is important, from both the top-down and bottom-up.
13. Health education and skill development workshops need to be ongoing to facilitate better understanding of health issues such as stress to reduce fear and poor responses to pain and stress.
14. Section leaders and conductors need to approach all musicians with respect.

7.1 Introduction

A series of in-depth semi-structured interviews were conducted with a group of musicians and their managers from one section of one of the symphony orchestras in the Sound Practice project. The goal of this was to find out what the musicians and managers understood about injury, their approaches to managing injury, and what the experiences had been of several players who had suffered chronic debilitating pain.

7.2 Study one: The role of work organisation and psychosocial factors in injury risk

Musicians and orchestral managers perceived that there are stressors in the orchestral environment that increase injury risk. The stressors reported by these musicians included: performance stress; work organisation, lack of control and complex interpersonal demands. The nature of orchestral work also led some musicians to indicate that they felt that at times their ability as an artist was compromised by feeling like they were being treated as 'note producers' working in a 'note factory' – a factor worsened in some instances by the approach of certain conductors or section leaders.\

7.3 Study two: Organisational culture, behavioural norms and attitudes to injury

From a series of interviews, an orchestral culture was found to exist whereby musicians see injury as a sign of weakness, failure and poor musicianship. Such negative perceptions of injury influence musicians to play through considerable levels of pain and to continue performing with injuries without reporting these unless they become severe. Fear of this perceived judgement from the orchestral group, led to the musicians reporting that they would conceal injuries from colleagues and

management staff. Casuals musicians in particular felt that disclosing injuries may lead to decreased work opportunities and were concerned that 'opening up' about injury may also subject them to group judgement about their technique or musicianship.

7.4 Study three: The effect of psychosocial factors on the experience of orchestral musicians undertaking rehabilitation

injury concealment played a considerable role in the development of chronic injuries for these musicians. Management staff reported concerns that this may be the norm amongst orchestral musicians, often despite their efforts to encourage reporting of work-related injuries. The musicians in this study reported suffering emotional and psychological trauma as the result of their injuries and two participants felt socially marginalised.

Chapter Summary

3. These findings highlight the importance of health education and training to be provided regularly and in an ongoing manner to orchestral musicians and managers to reduce fear, stigma and inappropriate behaviours surrounding these conditions. These should cover such topics as ways to effectively manage stress, preventing and managing injuries effectively and quickly, and understanding pain and recovery.
4. Future efforts should work to create sustainable, healthy orchestral cultures that view employee health as part of planning for a successful business.
5. Early reporting of injuries should be encouraged

7.5 Published Papers

1. Rickert, D. L., Barrett, M. S., & Ackermann, B. (2013). Injury and the orchestral environment: Part I. *Med. Probl. Perform. Art*, 28, 219-229.
2. Rickert, D. L., Barrett, M. S., & Ackermann, B. J. (2014). Injury and the orchestral environment: part II: organisational culture, behavioural norms, and attitudes to injury. *Med Probl Perform Art*, 29(2), 94-101.
3. Rickert, D. L., Barrett, M. S., & Ackermann, B. J. (2014). Injury and the Orchestral Environment: Part III. The Role of Psychosocial Factors in the Experience of Musicians Undertaking Rehabilitation. *Medical problems of performing artists*, 29(3), 125.

CHAPTER 8 – SOUND EXPOSURE AND HEARING CONSERVATION FOR ORCHESTRAL MUSICIANS

Key Findings

1. Orchestral musicians are an at risk population for noise induced hearing loss (NIHL)
2. Noise related hearing pathologies are more prevalent amongst orchestral musicians than the normal population
3. Musicians need to be able to exercise high levels of control over timbre, intonation, balance and dynamic contrast whilst conserving their hearing
4. 80% of musicians surveyed reported being at risk of hearing damage playing in orchestras
5. 43% of musicians reported hearing loss
6. 64% of musicians report using earplugs at some time but there is widespread difficulty reported with their usage

8.1 Introduction

The hearing conservation element of the *Sound Practice Project* involved initially an extensive literature review followed by a multi-phase program of investigation.

The literature review confirmed that orchestral musicians are at risk of hearing loss while playing their instrument and uncovered several sound exposure control and hearing conservation programs being used in professional orchestras – mostly in the United Kingdom and Australia. The review also highlighted the need for further research into sound levels experienced by musicians in private practice; the efficacy of large acoustic screens used in orchestras; and advances in earplug technology.

8.2 Study (a): Hearing conservation practices in Australian Orchestras

The first study investigated hearing conservation strategies and procedures in use in each of the orchestras in the Sound Practice study group and found a variety of approaches, some of which were comprehensive. Further training for orchestral management and operational staff was highlighted as an area needing attention, as was a more uniform approach to hearing conservation in Australia's orchestras. Results of this project were published in the *Journal of Occupational and Environmental Hygiene*, July 2012.

8.3 Study (b): Musician hearing health, hearing conservation and use of protection devices

The second investigation surveyed all of the musicians in the study group to determine their self-perceived hearing health, and attitudes to and engagement with hearing conservation measures, as well as use of and difficulties with hearing protection devices. Forty-three percent of musicians reported a hearing loss and 80% believed they were at risk of noise induced hearing loss while playing in the orchestra, while only 20% believed they faced similar risks in private practice. Up to 64% used hearing protection at least some of the time, although 84% of these players found earplug use difficult or impossible. Results of this study were published in Noise and Health, May-June 2014 (Table 4).

Table 5: Hearing and hearing conservation practices by instrument section

Variable	Upper strings (n=158) (%)	Lower strings (n=53) (%)	Woodwind (n=61) (%)	Brass (n=65) (%)	Percussion (n=17) (%)
Reported hearing loss	44	38	39	50	41
Reported hearing loss (≤ 50 y.o.)*	38	23	36	50	27
Tinnitus some/all of the time	49	47	56	54	75
Perceived risk of NIHL due to playing in the orchestra	77	77	88	83	82
Perceived risk of NIHL due to playing in private practice ***	17	2	26	32	59
Earplug use **	62	66	77	51	88
Difficult/impossible to use earplugs**	81	83	89	95	59

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

8.4 Study (c): Sound exposure in professional musicians during private practice

Private practice is a daily activity for most professional musicians and was potentially a significant contributor to daily sound exposure levels, although this had yet to be described in the literature. Results of the study confirmed that some musicians were at similar risks of noise-induced hearing loss during private practice as faced while playing in the orchestra, information that will be essential in

developing more targeted and effective hearing conservation strategies. This study was published in the Journal of the Acoustical Society of America, August 2013.

8.5: Study (d): Noise exposure and attitudes to hearing protection in orchestral brass musicians

Compared with their colleagues in the orchestra, musicians of the brass section are exposed to the highest continuous levels of sound in the workplace. Little is known regarding sound level exposure during their private practice despite significant periods of time being spent engaged in this activity, nor has the hearing health and hearing conservation practices of this group in particular been the subject of focussed research. This has made exposure estimation and the development of appropriate hearing conservation approaches for this population very difficult.

This study aimed to assess practice room exposure levels, self-reported hearing health, and hearing conservation practices of orchestral brass players in particular. Ten professional musicians practicing comparable musical material were assessed for sound exposure and questionnaires were distributed to brass players of eight professional orchestras.

Findings indicated brass instrumentalists are likely to exceed acknowledged “safe” sound exposure limits in under an hour of private practice and that, of brass players surveyed (N=65), 50% of those under the age of 50 self-reported a hearing loss of some kind and 95% reported the use of hearing protection while playing was difficult or impossible. Improvements to personal protective devices together with enhanced education for musicians and their teachers, managers, and audiologists is essential to further safeguard the hearing of those in the field and those training to enter it. This study was published in the *Proceedings of the International Symposium of Performance Science, 2013*.

8.6: Study (d): Evaluation of an orchestra's hearing conservation strategy

A formal process evaluation was undertaken into the hearing conservation strategy of the orchestra with one of the more active programs in place, as identified in the initial investigation. The orchestra’s strategy had been in use for close to a decade and the evaluation included archival analyses, player and management focus groups, and an interview with the program’s administrator.

Results showed the program had successfully become a part of the orchestra’s and the musicians’ daily operations and significantly contributed to managing the risk of hearing loss in this population. Central to the efficient functioning and broader cultural acceptance of this program was a group drawn from across the orchestra charged with planning hearing conservation measures, assessing the successes and failures of previously implemented measures and further developing the program.

While some weaknesses in the orchestra’s approach were noted - particularly regarding usable personal protective devices and education and training - results illustrated the potential for further integration of hearing conservation behaviours into the daily operations of a professional orchestra. This study was published in the *Annals of Occupational Hygiene*, November 2014.

8.7 Conclusions

This program of inquiry described hearing conservation activities and attitudes in Australia's Orchestras, provided critical information for the further development of effective education tools and hearing conservation strategies (see Figure 6), confirmed and validated possible further control measures and personal protective devices suitable for use in professional orchestras, and highlighted challenges and solutions to the complex issue of appropriate hearing conservation approaches for symphony and pit orchestras.

8.8: Chapter Summary

It is well established that orchestral musicians may be exposed to levels of sound that risk permanent damage to their hearing. There needs to be an integrated and comprehensive approach to prevention of noise-induced hearing loss based on available evidence (see Chapter 12). This should include:

- a) Induction training on hearing conservation practices
- b) Regular (annual) training in hearing conservation
- c) Monitoring noise exposure regularly (including during personal practice)
- d) Quiet break and warm-up policies
- e) Mandating annual hearing testing for musicians
- f) Establishing clear processes for managing noise complaints/hearing injuries.

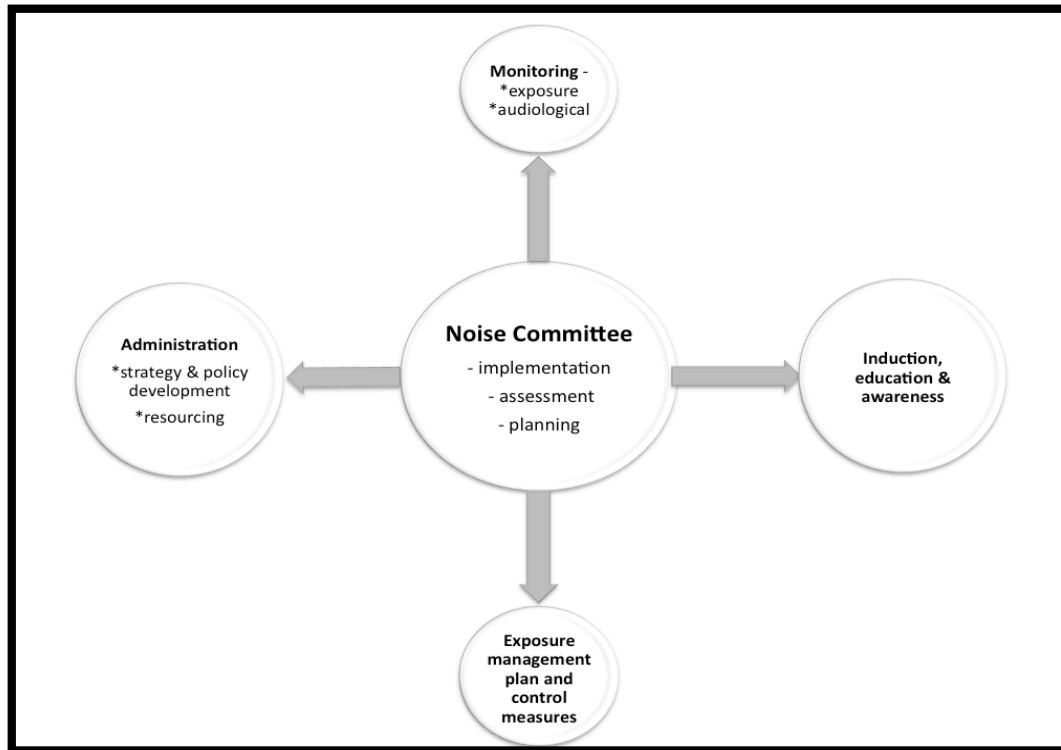


Figure 5: Hearing Conservation Strategies - elements and structures (O'Brien, Driscoll, Ackermann, 2014)

8.9: Published Papers

1. O'Brien, I., Driscoll, T., & Ackermann, B. (2012). Hearing conservation and noise management practices in professional orchestras. *Journal of Occupational and Environmental Hygiene*, 9(10), 602–608. doi:10.1080/15459624.2012.715519
2. O'Brien, I., Ackermann, B., & Driscoll, T. (2013). Sound exposure of professional orchestral musicians during solitary practice. *J Acoust Soc Am*, 134(4), 1–7.
3. O'Brien, I., Ackermann, B., & Driscoll, T. (2014a). Hearing and hearing conservation practices among Australia ' s professional orchestral musicians. *Noise and Health*, 16(70), 189. doi:10.4103/1463-1741.134920
4. O'Brien, I., Driscoll, T., & Ackermann, B. (2014). Description and evaluation of a hearing conservation program in use in a professional symphony orchestra. *Annals of Occupational Hygiene*. Published online prior to print, November 2014, 1-12. doi:10.1093/annhyg/meu092
5. O'Brien, I., Driscoll, T., & Ackermann, B. (2013). Noise exposure and attitudes to hearing protection in orchestral brass musicians. In A. Williamon & W. Goebel (Eds.), *Proceedings of the International Symposium on Performance Science* (175-180). Belgium: Association Européenne des Conservatoires.

SECTION 2: WHS

CHAPTER 9- WORK ORGANISATION AND PSYCHOSOCIAL RISKS

Key Findings

1. Psychosocial factors present in the professional orchestra environment are perceived to have an important impact on the health and well-being of the musicians
2. Extremely high lifetime prevalence of occupational injury rates amongst professional musicians' reported of 78-80%.
3. The perceived health risks in the orchestra are multiple, interrelated, and often out of the control of the musicians.
4. An Orchestral culture exists in which musicians see injury as a sign of weakness, failure, and poor musicianship. These negative perceptions of injury influence musicians to play through considerable levels of pain and continue performing with injuries.
5. Injury concealment played a considerable role in the development of chronic injuries including emotional and psychological trauma.
6. Pit Musicians (42%) were more likely to have had time off work due to pain/ injury in the preceding 18 months than stage (23%) or stage and pit musicians (26%)
7. 25% of musicians reported experiencing bullying in the preceding 3 months
8. Overall satisfaction amongst musicians was low with regards to their section leaders, pay and perceived career progression.

9.1 Introduction

The highly complex relationship between work organisation and psychosocial risks amongst professional orchestral musicians needed to be investigated to assess the degree to which work organisation and psychosocial risks may contribute to the risk of playing related issues.

The impact on the type of work environment in the literature has so far been unclear on reported work related health issues. However there has been an extremely high lifetime prevalence of occupational injury rates amongst professional musicians' reported of 78-80%.

9.2 Sound Project Assessments of Work organisation and Psychosocial risks

Three studies investigated the work organisation of professional orchestras and its relationship to psychosocial factors in musicians.

9.2.1 Study 1

Assessed 10 professional cellists and 5 management staff and looked at the perception of how work organisation contributed to risk of injury. Musicians perceived that stress in the orchestral environment increased the risk of injury. Stress was divided into two categories.

- Psychosocial injury risks
 - a) Performance stress
 - b) Interpersonal relationships
- Combined psychosocial and physical injury risks
- Work organisations (including orchestral scheduling, programming and rehearsal style)
- Lack of control

The findings from this study indicate that psychosocial factors present in the professional orchestra environment are perceived to have an important impact on the health and well-being of the musicians. The perceived health risks in the orchestra are multiple, interrelated, and often out of the control of the musicians.

9.2.2 Study 2

This study investigated the influence of organizational culture on injury outcomes for orchestral musicians. 10 professional cellists and 5 management staff were interviewed on their perceived influence of orchestral culture, behavioural norms, and attitudes to injury on injury outcomes for orchestral musicians.

The findings indicate that an orchestral culture exists in which musicians see injury as a sign of weakness, failure, and poor musicianship. Such negative perceptions of injury influence musicians to play through considerable levels of pain and continue performing with injuries. Because of perceived judgment from the orchestral group, musicians were found to conceal injuries from colleagues and management staff. The study suggests education measures which may be effective at influencing individual behaviours and attitudes as well as cultural change initiatives which could lead to long-term positive health outcomes in the orchestral workplace.

9.2.3. Study 3

Aimed at understanding the lived experiences of three chronically injured cellists to better understand their injury and rehabilitation experiences. The findings showed that injury concealment played a considerable role in the development of chronic injuries. The musicians reported significant emotional and psychological trauma as a result of their injuries with a high depression score related to their perceived injury stigmatization and social isolation. Musicians encountered medical staff as part of their rehabilitation who had a lack of understanding of the specialized requirements of elite orchestral musicians. Workplace rehabilitation in the orchestral setting therefore poses a number of challenges

due to the poor fit between generic injury insurance and medical care with the performance requirements of elite professional musicians. Recommendations made included the need for psychological screening and support for chronically injured musicians and the importance of a supported and staged return to work program that included appropriate workplace roles for the injured musician to maintain social contact and prevent loss of identity due to an inability to play.

9.3 Physical and Psychological differences between Stage and Pit orchestral musicians

There has been little evidence to indicate whether health issues differ according to work environment for classical orchestral musicians. This paper aimed to determine the impact that different work environments had on performer health to enable targeted workplace modifications to be made based on the findings.

The 380 full-time musicians from the eight major state orchestras were divided into three groups, depending on whether they belonged to stage orchestras only (n=3 orchestras; 36% musicians); pit orchestras only (n=2 orchestras; 21 % musicians), or combined stage and pit orchestras (n=3; 43% musicians) (Table 5).

Table 6: Frequency and percentage in stage, stage/pit and pit only orchestras

Orchestra	Males		Females		Total	
	n	%	n	%	n	%
Pit	45	52.9	40	47.1	85	100
Stage/pit	81	47.4	90	52.6	171 ¹	100
Stage	72	48.6	76	51.4	148	100
Total	198	49.0	206	51.0	404 ¹	100

1: the gender was not known for 3 stage/pit musicians

Findings indicated that:

- I. **Pain**- There was no statistical difference between stage and pit orchestral musicians in their pain reporting. 81-95% of all orchestral musicians reported pain/ injury at some stage in their career, 85-90% reported pain/ injury had affected their playing and 46-56% were currently playing with a pain/injury.
- II. **Time off work**- Pit musicians (42%) were more likely to have had time off work due to pain/injury in the preceding 18 months than stage (23%) or stage and pit musicians (26%).
- III. **Upper limb strength**- Stage musicians were found to have significantly less upper limb strength than pit musicians on most measures. In particular, there was a significant difference between shoulder internal rotation strength for both arms and elbow flexion and extension strength bilaterally. The relevance of this is unclear; however, they may reflect the subtle differences in

playing demands between the two different musical contexts - there may be an increase in endurance workload of pit orchestras.

- IV. **Music Performance Anxiety (MPA)** – Using the *Kenny Music Performance Anxiety Inventory* (KMPAI) there was significantly greater MPA in pit orchestra musicians than in stage orchestra musicians.
- V. **Bullying**- 25% of musicians reported at least one experience of what they perceived to be bullying in the preceding six months. Pit musicians (37%) were more likely to report experiencing bullying than stage musicians (17%). Note that bullying was assessed on a 5-point Likert scale and ratings were spread relatively evenly over the scale. This means that over half of those endorsing bullying experiences reported that they experienced bullying only a “a little” or “somewhat” compared with “quite a lot” and “very much.” Most definitions of bullying require that behaviour be repeated over time, so a more stringent definition of bullying would result in a much lower estimate than the one reported in this study. Orchestral management was perceived to be the most common source of bullying (30.5%). Future research should follow up to ascertain whether claims of bullying are actually reported and the response of management to those claims. For example, a musician might be disappointed with a manager’s decision and refer to this as bullying when it was actually judged to be a lawful directive. Although there is legislation to guide determinations of what constitutes bullying, managers may benefit from training in how to present lawful directives to musicians that musicians do not experience as bullying/shaming.
- VI. **Workplace satisfaction and happiness**- Stage musicians reported significantly higher levels of workplace happiness and satisfaction with their employers than pit or combined stage/ pit musicians. Overall satisfaction amongst musicians was found to be low with regards to their section leaders, pay and perceived career progression.
- VII. **Rates of Perceived Exertion (RPE)**- rates of perceived exertion were measured using Borg’s Ratings of Perceived Exertion (Borg, 1998) (Table 6). Significant differences were noted across each of the orchestras in their self -rated scale of perceived exertion. These included:
 - a. **Private practice**: Stage and stage/pit orchestra musicians reported greater RPE than pit only orchestra musicians
 - b. **Touring**: Stage orchestra musicians reported greater RPE than pit only orchestra musicians. They were also more likely to perceive touring as a contributing factor to the development of PRMDs.
 - c. **Rehearsing**: Pit orchestra musicians reported greater RPE than stage orchestra musicians
 - d. **Performing**: Pit orchestra musicians reported greater RPE than stage orchestra musicians. However pit/stage orchestra musicians reported greater RPE when performing on stage versus in the pit. (Figures 3-4)

Table 7: Borg's Rates of Perceived Exertion – circle the number on the scale below that most represents how exerted you feel playing in the particular performance situations

6
7 very very light
8
9 very light
10
11 fairly light
12
13 somewhat hard
14
15 hard
16
17 very hard
18
19 very very hard
20

Figure 6: RPE for Playing on Stage

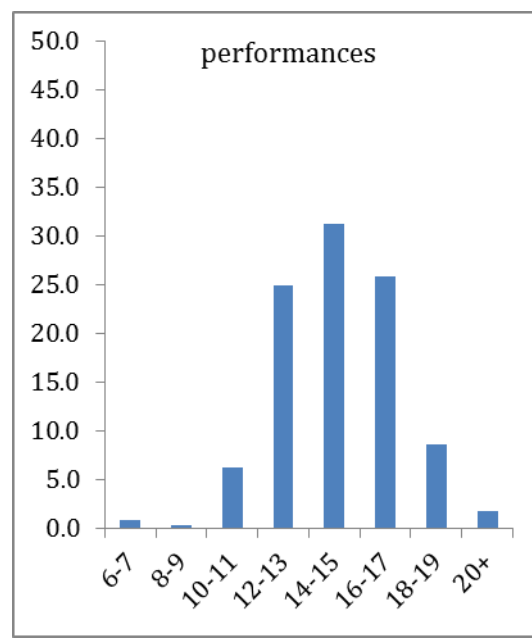
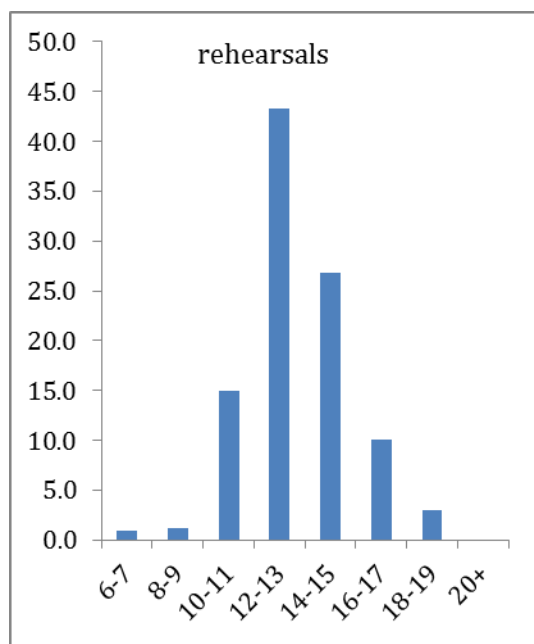
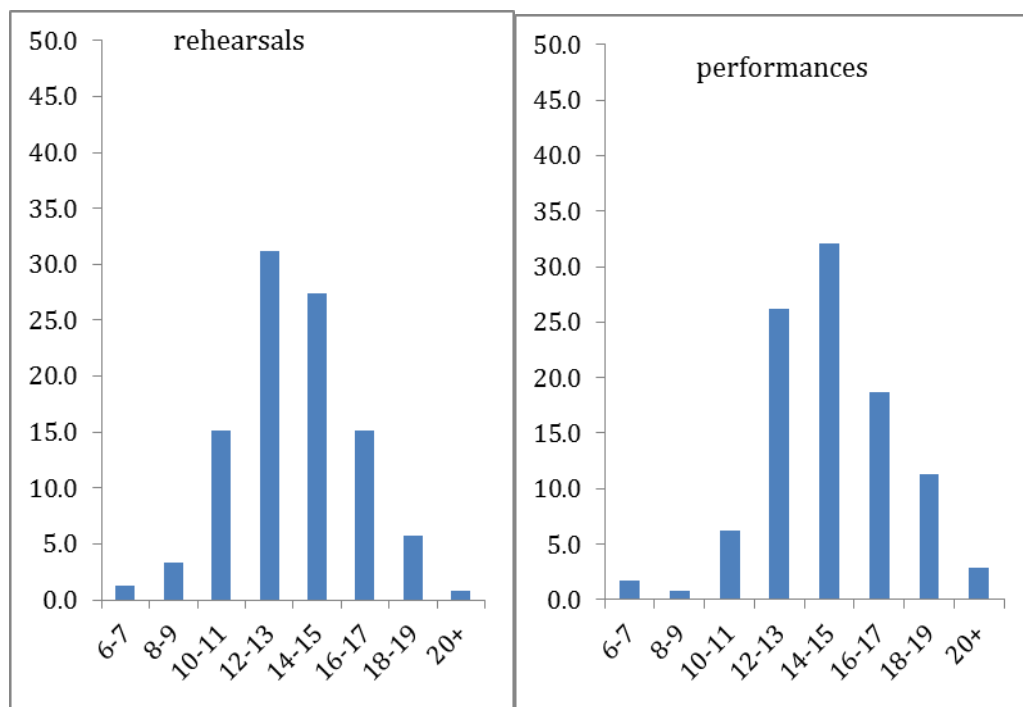


Figure 7: RPE for playing in pit



9.4 Chapter Summary

1. Psychological well-being needs to be addressed in musicians with significant performance related musculoskeletal pain
2. Evaluating orchestral injury risks within an organizational cultural and normative behavioral model represents a new approach in the field of performing arts medicine, and future quantitative research in this area is warranted
3. Orchestral workplaces appear to have different health risks according to the type of work being performed, particularly with poorer psychological health measures recorded by pit musicians
4. Education programs that highlight positive health cultures and pro-active and early detection and management of injuries in musicians are required
5. Return to work programs need to include finding appropriate workplace roles as a staging process to maintain social contact for injured musicians and prevent or ease personal identity crisis associated with an inability to play
6. Education of health professionals treating musicians on the elite performance requirements of professional musicians

9.5 Published Papers

1. Ackermann, B.J., Kenny, D.T., O'Brien, I., Driscoll, T. (2014). Sound Practice—improving occupational health and safety for professional orchestral musicians in Australia. *Frontiers in Psychology*, 5: 973. Published online 2014 Sep 9. doi: [10.3389/fpsyg.2014.00973](https://doi.org/10.3389/fpsyg.2014.00973)
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4158789/>
2. Kenny, D. T., Driscoll, T., & Ackermann, B. J. (2016). Is Playing in the Pit Really the Pits?: Pain, Strength, Music Performance Anxiety, and Workplace Satisfaction in Professional Musicians in Stage, Pit, and Combined Stage/Pit Orchestras. *Medical problems of performing artists*, 31(1).
3. Kenny, D. T., Driscoll, T., & Ackermann, B. J. (submitted 2016) Aging in professional orchestral musicians: Exertion, pain, injury, recovery, psychological wellbeing, and workplace satisfaction
4. Kenny, D.T., & Ackermann, B. (2013). Performance related musculoskeletal pain and depression in professional orchestral musicians. *Psychology of Music*, published online 2 September, DOI:10.1177/0305735613493953.
<http://pom.sagepub.com/content/early/2013/09/02/0305735613493953>.

CHAPTER 10 - WORKPLACE HEALTH AND SAFETY

Key Findings

1. An external consultant recommended improvements in several aspects of WHS management across all orchestras. These included:
 - a. Ensuring orchestras are maintaining compliance with legislative requirements
 - b. Taking all necessary steps in risk management
 - c. Better WHS Induction and training processes
 - d. Assessment of external venues
2. Recommendations are made to support improvement in relevant areas

10.1 Introduction

Most current WHS models do not have a focus on the assessment and maximisation of individual capacity for the specific work demands that are unique to professional orchestral musicians. The Sound Practice Project focussed on physical, psychological and auditory health research and interventions necessary to guide ongoing development of the most industry-specific guidelines. However, to evaluate existing WHS programs within the orchestras, the project team commissioned an external health and safety consultation and review for orchestras involved in the project. This review focussed on areas not specifically researched or addressed by the multi-disciplinary project team, and supported one of the final aims of the project. This was to provide recommendations for professional orchestral musician workplaces across Australia, encourage safe work practices, and reduce workplace risks according to the most recent WHS guidelines.

10.2 Workplace Health & Safety Site Visits

The review was conducted for the project by external contractor Richard Le Comte during late 2013. It commenced with a local site visit to each participating orchestra. Each site visit and subsequent review aimed to consider:

- Existing procedures and policies for standard WHS, including risk management plans, induction procedures, injury reporting practices, musician specific practices
- Work health and safety management in the orchestra and
- Compliance and transition with WHS harmonisation at a base level.

The goal was to provide an objective external assessment that orchestras could use when evaluating and revising their WHS practices and procedures, and to identify across the Sound Practice orchestras areas of OHS that were being well controlled and areas for which some improvement seemed warranted. The findings and recommendations are based on Mr Le Comte's report.

Each participating orchestra was provided with a report specific to themselves. Key aspects are summarised here.

10.3 Main Findings

The review of WHS produced several recommendations, which are summarised here for the consideration of orchestras.

1. Produce a common WHS intranet platform

All eight orchestras operate within the same constraints and face the same types of issues. Therefore the creation of an Intranet platform that is focussed on WHS and that is available only to the key stakeholders of the eight orchestras would serve as a useful and inexpensive resource for orchestras. The platform could serve as a repository of key information to assist decision makers make timely and well-informed decisions regarding WHS and to help them be aware of and meet their legal obligations under WHS.

2. Legislation

Orchestras could usefully review their legal requirements under the relevant legislation covering their operation.

3. Health and Safety Representatives

Orchestras should ensure that all Health and Safety Representatives are trained as specified in the relevant legislation.

4. Risk management

Each orchestra should ensure they have a single and complete risk register and all staff should have access to this register. Orchestras should also ensure they have comprehensive procedures in place to fully meet their obligations in terms of risk management of off-site venues and in terms of emergency procedures.

5. External venues

Orchestras should ensure they have comprehensive procedures in place to fully meet their obligations in terms of risk management of off-site venues.

6. Induction and training

Procedures covering induction and training should be reviewed to make sure they meet the requirements of the relevant legislation and of orchestral staff and other persons on site.

7. Noise management

Orchestras should review their approach to noise management, taking into account the guidance provided in earlier chapters regarding appropriate control measures to manage noise.

8. Manual handling

Orchestras should review their manual handling procedures to ensure they fully meet their obligations under the relevant legislation.

CHAPTER 11: ONLINE INJURY SURVEILLANCE

Key Findings

1. Collecting injury surveillance data from professional orchestral musicians has been challenging for a number of reasons
2. A comprehensive on-line surveillance tool has been developed which still needs to be formally trialled
3. The surveillance tool is intended to provide orchestras and individuals with detailed and on-going information to help prevent playing-related musculoskeletal disorders.
4. This information is an important input into a broader integrated approach to maximise the health and safety of musicians

11.1 Introduction and Background

The Sound Practice Project examined the feasibility of establishing a surveillance system to collect on-going information on pain and injury related to playing as well as the extent of exposure to potentially important injury risk factors.

11.2 Methods

A prototype surveillance system was developed for the project to trial with participants of any of the eight main professional orchestras in Australia. Three approaches to surveillance were developed – one paper-based and two web-based. All three essentially asked the same questions. The data collection instrument covered data on exposure (playing and non-playing activities), psychological parameters and on relevant outcomes (pain and injury).

11.3 Results

In general, collecting injury surveillance data from professional orchestral musicians has been challenging for a number of key reasons. Issues with the two-page, paper-based, system included allocating time for the form completion within or around the orchestra rehearsal schedule; balancing the frequency of data collection with the proportion of musicians who completed the forms; the level of detail of information collected; the areas covered by the data collection; the format of the form; and the musicians' perceptions of the usefulness of the information collected.

Uptake was better with the first web-based system but still low. The main issues identified were difficulties maintaining regular email contact (due to changing email addresses and firewall issues); developing a workable system of reminders; making the entry of data on anatomical site and symptoms simple; and maintaining interest amongst the musicians. Many of these issues have been addressed in a new system, developed in cooperation with the Dancer Wellness Project in the United States. This system is more menu-driven and easier for the musicians to use. It incorporates regular reminders and

provides feedback to allow the individual to compare their exposure data with others who play the same instrument and overall. This system is being trialled in 2015. The tool will be available long term for orchestras to continue to monitor injury and risk management in musicians.

11.4 Potential use of the surveillance system

The surveillance system has several potential uses for orchestras but it forms only a part of a broader surveillance system. The primary purpose of the system is to provide to orchestras and individual musicians detailed and on-going information about the extent and nature of playing-related musculoskeletal disorders and the exposures with which they are associated. This information is an important input into planning the prevention of such disorders and managing associated exposures. Once the system has been in use for a reasonable period of time the collected data can also be used to examine in detail the apparent relationship between playing-related and other exposures and the occurrence of musculoskeletal disorders. The tool should provide input into the work of the Musicians' Health Committee mentioned earlier in the report, which will also be responsible for the establishment and running of a triage system and health advisory service for musicians. The tool can be operated separately by each orchestra and, where orchestras agree, the data (de-identified) can be shared between orchestras to maximise use of the data.

The system will help orchestra management meet obligations under the Workplace Health and Safety Guidelines that relate to monitoring of worker's health ("...that the health of workers and the conditions of the workplace are monitored to prevent injury or illness arising out of the conduct of the business or undertaking...")*. The system, combined with the health advisory and education session, and early triage of musicians' musculoskeletal concerns, mentioned in earlier chapters, should make an important contribution to the effective prevention and control of playing-related musculoskeletal disorders in the musicians.

Note that the surveillance tool still needs to be properly trialled and the procedures for running the surveillance system in the longer term will need to be established. The Sound Practice team is committed to undertaking this and, if the orchestras request, to working with the orchestras to manage the system in the longer term.

The tool can be viewed at: www.musicianswellnessproject.com

11.5 Conclusions

This surveillance system should be a useful tool for orchestra management and musicians to better understand and manage factors that increase the likelihood of playing-related musculoskeletal disorders. The system need to be fully trialled. Arrangements then need to be put into place to ensure on-going management and support of the system and the appropriate reporting and use of the data. This includes establishing for each orchestra what level of information is available to orchestral management and musicians.

**(<http://www.safeworkaustralia.gov.au/sites/SWA/AboutSafeWorkAustralia/WhatWeDo/Publications/Documents/717/Guide-to-the-WHS-Act.pdf>)*

11.6 Chapter Summary

Injury surveillance allows ongoing identification of risk factors for health and well-being of orchestral musicians. Recommendations are:

1. Formal trial of the orchestral surveillance tool – available at www.musicianswellnessproject.com
2. Establishment of formal procedures to operate the system and use the data under the auspices of the Musician Health Committee.

11.7 Published Papers

1. Ackermann, B.J., Kenny, D.T., O'Brien, I., Driscoll, T. (2014). Sound Practice—improving occupational health and safety for professional orchestral musicians in Australia. *Frontiers in Psychology*, 5: 973. Published online 2014 Sep 9. doi: [10.3389/fpsyg.2014.00973](https://doi.org/10.3389/fpsyg.2014.00973) <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4158789/>
2. Driscoll, T., Ackermann, B.J., Galbraith, G. (2013). Surveillance of musculoskeletal disorders and risk factors in orchestral musicians. Published in: Williamon, A. & Goebel, W. (Eds). Proceedings of the International Symposium on Performance Science, Association Européenne des Conservatoires, Belgium 2013, pp: 171-174. <http://www.performancescience.org/ISPS2013/Proceedings/>

SECTION 3: INTERVENTIONS

CHAPTER 12 – PHYSICAL INTERVENTIONS

Key findings

1. Short-term treatment interventions such as massage may be beneficial during particularly intensive playing periods.
2. Warm-up activities to be included in pre- performance routine
3. Musicians need to be actively reminded to carefully plan external activities (including teaching) to manage orchestral demands.
4. Orchestral management has shown varying levels of support for musicians to maintain physical health and this should be encouraged to continue and expand.
5. The availability of health professionals is an effective way to encourage self-management and early reporting of injuries

12.1 Introduction

From these assessment findings (see Chapter 3) and existing literature recommendations a series of interventions were conducted. These included:

- a) Short on-site treatments during busy workloads (massage or physiotherapy);
- b) Exercise classes focussing on muscles that support playing actions;
- c) Warm-up trials for a sub group of musicians
- d) Alexander technique group lessons;
- e) Follow-up biomechanics sessions to further enhance technical changes; and
- f) Regular health education sessions.

As a general summary, participating in any of the physical trials provided positive benefits to the vast majority of participants, suggesting that musicians should be proactive in maintaining their physical health.

12.2 On-site injury diagnosis and advice (triage)

A group of experienced physiotherapists were trained in following a triage protocol where they were available on a fortnightly basis for three months in orchestras to diagnose injuries and provide on-site injury management and referral advice. Of the 83 musicians who attended these services, 79% of musicians rated the advice received as helpful or very helpful. 68% of the participating musicians responded that they were likely or very likely to continue the use of the service if provided in the future. The vast majority of the injuries seen at these sessions were reported to be performance-related

musculoskeletal disorders and were considered to be potentially preventable by the assessing physiotherapists.

These results support the value of having regular injury advisory services run by experienced and qualified health professionals, such as doctors or physiotherapists on site at orchestral premises to encourage earlier diagnosis and appropriate management of performance- related injuries.

12.3 Exercise classes and DVD development

- Exercise classes were offered to all orchestras over a ten week period and were designed to be able to be run in lunch breaks to facilitate uptake of the classes.
- 78 participants attended over 80% of the classes.
- Results showed a decrease of frequency and severity of playing related symptoms. However six months after cessation of classes these positive changes were no longer present reflecting the need for ongoing participation in musician specific exercise programs.
- An exercise DVD was created containing the same exercises used in the musician specific exercise classes and made available for musicians unable to attend the classes. Musicians received a copy of the DVD with accompanying exercise equipment and instructions. The DVD was designed to be added to the musicians' usual health care routine, and musicians were encouraged to continue with any existing exercise regimes or health provision services.
- 144 musicians out of a possible 576 participated in this trial. This represented 25% of all musicians in the eight orchestras. Seventy-one participants replied to the post-intervention questionnaire.
- Results demonstrated significant reductions in PRMDs frequency and severity, and the use of the exercise DVD was associated with positive perceived effects on muscle strengthening, flexibility, posture and ease of movement, which are reported to decrease the risks associated with PRMDs. (Table 6)

Table 2. Comparison between exercise DVD programme and the face-to-face exercise programme (*n* = 18)

Comparison items	Rating scale <i>n</i> (%)				
	Much worse	Worse	Same	Better	Much better
Instructions	0 (0)	0 (0)	13 (72)	4 (22)	1 (6)
Demonstrations	0 (0)	0 (0)	8 (44)	8 (44)	2 (12)
Precautions and warnings	0 (0)	0 (0)	13 (72)	4 (22)	1 (6)
Providing alternatives and variations to exercises	0 (0)	0 (0)	13 (72)	4 (22)	1 (6)
Motivation	1 (6)	1 (6)	9 (50)	6 (33)	1 (6)
Convenience	0 (0)	1 (6)	1 (6)	10 (55)	6 (33)
Overall exercise DVD compared with face-to-face classes	0 (0)	1 (6)	7 (39)	6 (33)	4 (22)

Comparison between exercise DVD program and the face-to-face exercise program (*n* = 18) Table from: Chan, C., Driscoll, T., Ackermann, B. (2014). Exercise DVD effect on musculoskeletal disorders in professional orchestral musicians. *Occupational Medicine*, 64, (1), 23-30.

12.4 Effect of warming-up on muscle activity patterns in violinists

Warming-up is considered to prepare the body for upcoming exercise. Theories behind warm-up suggest that it may be useful when treating a musician coming back from injury prior to returning to play, but also routinely pre-performance to get musicians ready to play. In this part of the Sound Practice project 55 violinists participated in a warm-up study. They were split into 4 groups:

- Control
 - o Consisted of 15 minute silent sitting
- Core
 - o Consisted of the regions of Hips, shoulders, & abdominals (“core pillar”) each warmed-up in 3 planes of movement
- On-instrument
 - o Consisted of a “typical” 15-minute warm-up (as per fitness norms)
- Cardio
 - o Consisted of a fast walk→Rated Perceived Exertion (RPE) = 11-13 (moderately intense exercise level)

Each violinist performed 5 excerpts requiring differing bowing demands with electrodes measuring muscle activity attached to the trunk and right arm. Each violinist then completed questionnaires regarding PRMDs and fitness levels, and performances were recorded pre and post warm-up to compare sound quality.

Results demonstrated that:

- There were no significant differences detected in muscle activity levels pre and post warm-up. Different repertoires showed very different muscle activation patterns to achieve the varying bowing demands.
- The presence of performance-related musculoskeletal disorders did not change the effect of warm-ups.
- However, musicians all felt they played better after any kind of warm-up compared to the control condition.

This may imply that instead of having an effect on making muscle activity, warm-up may act in other ways, for example increasing circulation to working muscles. More research is needed to explain these findings.

In addition, this study identified highly variable muscle activity patterns exist for playing different repertoire in terms of the bow arm actions, and indicated that the right forearm may be particularly vulnerable to higher muscular demands. This was further exacerbated if the violinist had pain in the right arm.

This reinforces the need for personal practice at least to be adapted in terms of duration according to the repertoire being played. Further study needs to be performed to evaluate the potential impact of this during orchestra rehearsals, which are often of longer duration than the actual performances.

12.5. Music Performance Biomechanics Assessment - video biofeedback

In the music performance biomechanics feedback study, performers were videotaped during their usual rehearsal situations. Actions that were identified to potentially create a higher risk of physical strain within an individual musicians' technique were discussed with the performer while viewing the footage from the previous rehearsal. This approach aimed to provide individualised playing movement advice that aimed to facilitate performers being able to integrate key aspects into their own particular technique. This approach is very common in Sports Medicine, and it is usual for athletes to regularly have their playing mechanics reviewed and individually refined in order to improve their performance, as well as prevent the risk of injury.

A video camera was used during rehearsals and performances to capture footage of volunteer musicians playing their instrument from various vantage points. The goal of this was that an experienced physiotherapist, the lead investigator Bronwen Ackermann, would then review performance from a clinical biomechanics perspective and then give feedback to the musicians themselves. The feedback was discussed in light of the performers own musical background and instrument set-up to ensure it was as individualised and relevant as possible. Post-feedback surveys indicated highly positive perceived benefits of reviewing their movements during playing, both in regards to decreasing pain and in relation to movement enhancement within technique.

A template was developed and trialled with elite student musicians for movement assessment to standardise assessment approaches, to enable easier training of other physiotherapists to learn to undertake this process. This template is under revision for future trial with professional orchestral musicians.

12.6. Short term massage and injury management trial

A brief trial of triage that included treatment and short massage was introduced at one of the participant orchestras (AOBO). The purpose of this trial was to evaluate whether short treatments provided over a very busy music season could reduce injury likelihood and support the working musicians. Short-term massage (10 minutes) has been proven to be beneficial to athletes during higher training loads, and the provision of physiotherapy services has been reported to be beneficial in preventing injuries on orchestra tours.

In total, 32 participants representing all instrumental groups were seen over the course of 80 triage visits during the trial. Over half (18 participants) were seen multiple times for management of their physical symptoms. In over half of these triage visits (41 of 80 visits), massage was used as an injury

management technique; management advice was given in 30 visits, exercises were prescribed in 26 visits, and stretches and joint mobilisations were each used in 7 of 80 visits.

Overall, 25 of 32 participants described their injury as being “chronic” or “recurrent.” Triage staff reported that the injuries of 20 of 32 participants were performance related and also that the injuries of 23 of 32 participants were preventable.

Feedback was only received from a limited number of returned questionnaires, which limited full evaluation of this study. However, the feedback received was overwhelmingly positive from the musicians and the perception of the respondents was that it not only helped them to cope, but they felt that some extra care was being taken of them at this busy time. Orchestral management felt that injuries would have been worse without this intervention given their previous experience with similar schedules in the past. While further research is needed, the comments to date indicate that short treatments including massage may be useful to decrease the risk of injury during busy programs.

12.7 Chapter Summary

Physical preparedness

The phenomenon of the musical athlete needs to be acknowledged and embraced by musicians, management and health professionals to provide a comprehensive and specific fitness and wellness guide.

This study suggests the following should be included:

1. Interventions that increase core strength of trunk and supporting playing muscles, but not those that overload muscles already used extensively during playing (eg: hand, elbow and face muscles).
2. Techniques that help reduce tension in the arms during playing. These include video feedback sessions
3. Cardiovascular fitness for general increased physical energy and improved mental health. Activities such as powerwalking or cycling, swimming using a variety of strokes (backstroke) will ensure that overworked musculature are not inappropriately loaded.

Injury management

Awareness of the need for best practice management of injuries with professional musician needs to include:

1. Encouragement of early reporting
2. Establishment of an early management policy for health issues according to WHS guidelines including consultation with rehabilitation providers
3. Establishment of a protocol for formal arrangements with experienced health professionals (General Practitioner, physiotherapist, audiologist, psychologist)

12.8 Published Papers

1. Chan, C., Driscoll, T., Ackermann, B. (2012). Development of a Specific Exercise Program for Professional Orchestral Musicians – A Methodological Study. *BMJ Injury Prevention* 19 (4), 257-263.
2. Chan, C., Driscoll, T., Ackermann, B. (2014). The Usefulness of On-Site Physical Therapy-Led Triage Services for Professional Orchestral Musicians - A National Cohort Study, *BMC Musculoskeletal Disorders*
3. Chan, C., Driscoll, T., Ackermann, B.J. (2014). Effect of a musicians' exercise intervention on performance related musculoskeletal disorders. *Medical Problems of Performing Artists*, 29 (4), 181-188.
4. Chan, C., Driscoll, T., Ackermann, B. (2014). Exercise DVD effect on musculoskeletal disorders in professional orchestral musicians. *Occupational Medicine*, 64 (1), 23-30.
5. Chan, C., Ackermann, B. (2014) Evidence informed physical therapy management of performance related musculoskeletal disorders in musicians. *Frontiers in Psychology*, 5, 706.
6. McCrary, J.M., Halaki, M., Sorkin, E., & Ackermann, B.J. (2016). Acute Warm-up Effects in Submaximal Athletes: An EMG Study of Skilled Violinists. *Medicine and Science in Sports and Exercise*. Available online at: <http://journals.lww.com/acsm-msse/pages/articleviewer.aspx?year=9000&issue=00000&article=97700&type=abstract>
7. McCrary, J. M., Halaki, M., & Ackermann, B. J. (2016). Effects of Physical Symptoms on Muscle Activity Levels in Skilled Violinists. *Medical Problems of Performing Artists*, 31(3), 125.

CHAPTER 13– PSYCHOLOGICAL INTERVENTIONS

Key Findings

1. Development of new theoretical model offers typology of music performance anxiety
2. ISTDP may be a useful therapy for cases of severe music performance anxiety

13.1 Introduction

This study presents a case study including the assessment, process and outcome of an intensive short term dynamic psychotherapy for a professional orchestral musician who had symptoms of severe music performance anxiety over a 30 year period. The musician underwent 10 sessions of ISTDP over a four month period.

13.2 Short –term Dynamic Psychotherapy

A new theoretical model was developed for the aetiology of music performance anxiety from which was derived a typology of music performance anxiety and suggested treatments for each cluster. This theoretical model supposes that some cases of music performance anxiety have their origins in complex and unresolved emotions and defences from ruptures to early (before 8 years old) attachment relationships. The anxiety that can be generated by repressed emotions can manifest itself in

- striated muscle tension
- smooth muscle anxiety leading to gastro intestinal disturbances,
- cognitive perceptual disruption, and
- motor conversion.

A trial therapy protocol was developed and trialled, based on the Intensive Short-Term Dynamic Psychotherapy (ISTDP) model. The therapist aimed to maintain the therapeutic focus and active therapist involvement throughout the treatment.

13.3 Conclusions

The outcome for this musician was positive. He was able to resolve emotional trauma from early life, and this, in turn, resulted in significantly decreased music performance anxiety during performance. Further research is needed to identify those musicians most likely to benefit from this more intensive psychodynamic treatment approach.

13.4 Chapter Summary

1. Careful assessment of the type of music performance anxiety (i.e., focal, related to generalized social anxiety, or as an expression of wider vulnerabilities in musicians with fragile personality structure) needs to occur to direct musicians to appropriate interventions.
2. This advice should be sought from a general practitioner or a registered psychologist

13.5 Published Paper

1. Kenny, D.T., Arthey, S. and Abbass, A. (2014). Intensive short-term dynamic psychotherapy (ISTDP) for severe music performance anxiety: The assessment, process and outcome of psychotherapy with a professional orchestral musician. *Medical Problems of Performing Artist*, March 2014, 3-7.

CHAPTER 14 – SOUND EXPOSURE INTERVENTIONS

Key Findings

1. Large protective screens may exacerbate exposure for those already at high risk
2. Trial of an acoustic screen in use showed effective techniques for managing this issue
3. Personal protective devices need to be usable over entire dynamic range and minimally distort perception for the musicians
4. Trial of electronic earplugs showed positive results and provide evidence of a more usable hearing conservation tool

14.1 Introduction

One of the more challenging aspects of hearing conservation in an orchestra is implementing exposure controls that do not compromise the musicians or the orchestra artistically. Carefully planned in response to data from a sound level monitoring program, all exposure controls must be implemented according to the recommended hierarchy, as stipulated in the relevant Code of Practice for managing sound exposure in the workplace. In order to achieve this with minimal artistic impact, it is essential to have the most appropriate tools available and fully understand the impact any controls may have.

Two such controls investigated during the Sound Practice Project were the use of sectional acoustic screens and recent developments in personal hearing protection for musicians, seen as the very final implementable control measure in the hierarchy.

14.2 Clinical trials in Personal Protective Devices (Electronic earplugs)

Newly developed personal protective devices in the form of electronic earplugs were subjected to a clinical trial. As earlier inquiries had highlighted, orchestral musicians had significant difficulties using currently available earplugs, even those specifically designed for musicians. Although usage rates amongst Australia's orchestral musicians were notably higher than those reported in European studies, most musicians found the use of earplugs while playing their instrument as difficult or impossible, with many rejecting the devices altogether.

During the trial, 26 musicians used these newly developed earplugs during 4-6 weeks of rehearsals and performances, with their reactions and adaptation to the devices recorded (Table 9). The earplugs were also subjected to laboratory and clinical testing.

TABLE 8. Abilities reported with earplugs prior to, partway through and at the conclusion of earplug trial (%)

	Passive earplugs		Electronic (partway through trial)		Electronic (trial conclusion)	
	n	%	n	%	n	%
No problem	0	0	1	5	4	18
Mild difficulties	5	23	11	50	5	23
Difficult	14	64	9	41	11	50
Impossible	3	14	1	5	2	9

Results showed that these new devices were significantly more usable in an orchestral context than currently available devices, particularly regarding the musicians' abilities to hear themselves and others, and to distinguish correct intonation while wearing the earplugs. The study was published in the Journal of Occupational and Environmental Hygiene, July 2014.

14.3: Assessment of an acoustic screen in use in one of the orchestras in the Sound Practice study group.

There are significant issues with large acoustic screens when used for exposure management in an orchestra, including obstruction of sight lines and the exacerbation of exposure to players 'upstream' of the screens. Investigators identified a possible solution to this issue in a screen being used in front of high level instruments (trumpets) in an orchestra pit. The screens were designed to reduce exposure to those seated in front of the trumpets while having negligible impact on the exposure of the trumpet players themselves. The study took a series of measurements to determine whether these claims were verifiable. Results confirmed that the screens functioned mostly as intended and identified possible uses for similarly designed screens in other orchestral situations. Details of the study were published in the journal Acoustics Australia, August 2013.

14.4 Chapter Summary

1. Develop bespoke sectional screens that have minimal impact on the sound exposure of musicians 'upstream'
2. Make personal acoustic screens easily available (e.g. Goodear screens)
3. Consider set-ups that may assist in the reduction of noise issues (e.g. the use of risers, distance between players, avoid loud instruments being under pit overhangs if possible, noise rostering)
 - Supply purpose-designed musicians' earplugs

14.5 Published Papers

1. O'Brien, I., Driscoll, T., Williams, W., & Ackermann, B. (2014). A Clinical Trial of Active Hearing Protection for Orchestral Musicians. *Journal of Occupational and Environmental Hygiene*, 11, 450–459. doi:10.1080/15459624.2013.875187
2. O'Brien, I., Wood, J., & Ackermann, B. (2013). Assessment of an acoustic screen used for sound exposure management in a professional orchestra. *Acoustics Australia*, 41(2), 149–153.

CHAPTER 15: EDUCATIONAL INITIATIVES FOR ORCHESTRAL MUSICIANS

Key Findings

1. Education forms the cornerstone of all Sound Practice Project Initiatives and Interventions
2. Education promotes good communication and collaboration between musicians, health professionals and music administrators
3. Education is an important first step in allowing musicians to understand their playing requirements and potential impairments which then allows for more effective therapeutic interventions and injury management
4. Main causes of injury still relate to poor practice planning and scheduling

15.1 Introduction

Currently there is little or no health education or support for either novice or experienced musicians or a musicians' health training program for health care practitioners in Australia. Therefore musicians may have a lack of understanding of injury causation or optimal general health practices and injury management. Healthcare practitioners who have done no formalised musician specific health training may only be able to give non-specific injury management advice without a clear rehabilitation direction to help musicians regain full musical performance capabilities.

Education forms the cornerstone of all the initiatives developed and implemented by the Sound Practice Project. Education is an important first step, in helping musicians understand the physical, psychological and auditory requirements of their respective instruments and job roles. A basic knowledge of the relevant health topics will assist musicians in understanding the bodies' response to the strain of playing an instrument and the demands of being a professional orchestral musician. Education helps musicians to understand the impact of common risk factors and the strategies that should be adopted to modify these risk factors and allow injury prevention or appropriate injury management, including treatment and recovery. Education is therefore crucial in the development of sustainable and optimal treatment strategies and regimes for orchestral musicians.

15.2 Education Initiatives and Interventions

15.2.1 Education of Musicians

Education talks were offered annually to all orchestras during the Sound Practice Project duration 2009-2014. Uptake varied between orchestras with some taking full advantage of this initiative and others not as enthusiastic in their responses. There were four main topics covered which included:

1. General Health requirements (including hydration, nutrition and fitness)
2. Hearing Health

3. Psychological Health
4. Physical Health and injury management

15.2.2 Education of Music Administrators

Members of the orchestra's administration were included in these regular education sessions and their respected feedback was regularly sought. The education sessions were refined and updated in line with the ongoing Sound Practice Project results.

15.2.3 Education of Health Professionals

Education of health professionals is a necessary part of good team management. A thorough understanding of the biomechanical requirements of the various instruments and of sound production is required so that subsequent interventions are able to effectively combine the physics of body motion with the physics of sound production. Education also allows for collaboration and good communication to be facilitated between health professionals, musicians and music administrators.

15.3 Results

Informal feedback was the only feedback received due to the difficulty in statistical data gathering and inconsistent participation. From this however it was found that an increase in specificity of topics led to a greater perception of education having been received by the participants. The practical tips suggested by the education sessions within the four main topics were deemed to be the most useful. In particular education on the appropriate course of action for acute injury management and the importance of early seeking of expert medical advice was well received.

15.4 Conclusions

Education of musicians, music administrators and health care professionals is crucial in the development of sustainable and optimal injury management treatments and management pathways. Musicians, music administrators and healthcare professionals need to be educated within their specific topics regarding best evidence practice for musician health and well-being and the ongoing best practice identification and management of musician specific injuries. The uptake of educational opportunities can be facilitated by entry level face to face sessions with musicians, relevance making of education to all musicians and support of all teachers, institutions and healthcare practitioners. Future recommendations in the area of education include formalised healthcare training in musicians' health and clear provision for education programs for all musicians.

15.5 Chapter Summary

1. Education needs to include topics specific to musicians health, well -being and injury management as well as general health education
2. Education needs to be directed towards musicians, music administrators and healthcare professionals
3. Education needs to be a regular and ongoing part of WHS strategies within orchestras
4. Education needs to include practice planning training
5. Development of formalised musicians' health training programs for healthcare practitioners is needed

SECTION 4: THE FUTURE

CHAPTER 16: DEVELOPMENT OF HEARING CONSERVATION STRATEGIES

Key Findings

1. General hearing and ear health should be a priority for all musicians who rely on this sense for their livelihood.
2. Hearing Conservation strategies are a necessary part of WHS guidelines
3. In order to implement practical programs that comply with WHS guidelines orchestras must devise strategies specific to the orchestral workplace
4. There are many evidence-based control measures which are effective in sound exposure reduction
5. A comprehensive approach involving a well-articulated strategy managed by a small group of internal stakeholders from across the organisation has been shown to be very effective in implementing and maintaining orchestral hearing conservation measures

16.1 Introduction

Professional orchestras are bound by WHS regulations obliging them to provide a safe working environment that conforms to restrictions stipulated by this legislation. To comply with these regulations and ensure musicians progress through their careers with intact hearing, workplace hearing conservation measures and sound exposure risk management strategies are necessary. To do this without damaging an orchestra's product (music) or unduly restricting the musicians from being able to play to the highest level is a complex task involving carefully designed and implemented strategy.

It is reasonable for an employee to expect that all risks to their hearing are properly monitored, documented and understood by the employer, and that suitable control measures are in place in time to protect their hearing. Sound exposure to orchestral musicians, however, is highly variable in duration, intensity and source, making assessment of exposure a much more complex matter.

The following recommendations aim to facilitate compliance with *Safe Work Australia's* 2011 Code of Practice: *Managing Noise and Preventing Hearing Loss at Work* (Safe Work Australia, 2011) (CoP) within an orchestral workplace. There may be some differences between requirements in Safe Work Australia's document and those contained in Codes of Practice specific to each State, and this should be considered alongside the recommendations below.

16.2 Development of orchestral hearing conservation strategies

Developing and maintaining a successful hearing conservation strategy within a professional orchestra is a complex task involving a fine balance of legislative requirements, control measures, exposure

assessment, audiological monitoring and educational programs that must integrate artistic, financial and political concerns.

There are several elements involved in planning, implementing and maintaining a successful orchestral hearing conservation strategy that have been made apparent and evolved with the Sound Practice Project. These include:

- Nominate **key staff** to accept oversight for the continued successful operation of the program, including resourcing.
- **Form a working group or committee** made up of players, operational staff, artistic staff and upper management charged with implementing, maintaining and progressing a flexible hearing conservation strategy
- Implement regular, ongoing **sound exposure and audiological monitoring programs**.
- Develop targeted, effective **control strategies** according to the hierarchy of controls.
- Implement an **exposure management plan** that identifies areas of risk within the orchestra (based upon the monitoring program), recommends effective control measures on a program-by-program basis and communicates the various risks to the effected musicians.
- Ensure **training and education** occurs at induction and regularly throughout any employee's engagement (for casual, short-term and permanent employees). This also applies to management staff.

16.3 Working group and cultural acceptance

Fundamental to ensuring a workplace hearing conservation strategy is both effective and sustainable is its acceptance by the employees and management. The involvement of respected and knowledgeable players as well as operational, artistic and executive staff is considered the approach most likely to have a lasting impact and to stand the greatest chance of becoming culturally entrenched. The Sound Practice Project has observed successes and failures in orchestras both in the UK and in Australia, with the defining difference being the presence or absence of a central working group comprised of a team representing all relevant areas of the organisation overseeing a detailed strategic approach.

Such a team is able to provide program-by-program recommendations and planning for upcoming high-level events; retrospectively assess successes and failures of the program; ensure communication of risk and control measures are disseminated to all relevant areas of the organisation; assess and manage the artistic impact of controls; assess and manage the impact of operational and artistic decisions upon planned controls; ensure monitoring programs (both audiological and sound level) are occurring in a timely fashion and that data is being appropriately used to inform decisions; and finally to plan education and training activities.

16.4. Monitoring programs

16.4.1 *Sound exposure monitoring*

An exposure monitoring program is essential for any effective hearing conservation strategy and must be supported by a comprehensive management strategy which uses the data gathered to implement considered, effective control measures and to provide the basis of adequate education and training for the musicians and their operational staff. An active monitoring program also gives visibility to the hearing conservation strategy and encourages cultural acceptance of its place in the organisation.

The nature of orchestral sound exposure

Sound exposure to individuals is measured according to both intensity of sound experienced at the ears and the duration of this exposure, with very specific limits set for workplace exposure for any work shifts falling within a 24-hour period. Peak (or instantaneous) sound events also have a limit set in the legislation. All legislated limits are based upon what is considered safe for the vast majority of the population should they be regularly exposed.

In workplaces with reasonably predictable sound levels (such as factories) it is a relatively simple procedure to assess sound exposure to employees and extrapolate the expected exposure based upon hours to be worked. Sound exposure to orchestral musicians, however, is highly variable in duration, intensity and source, making assessment exposure a much more complex matter.

There is much research that gives indications of observed exposure and levels of risk by instrument played, but this research also highlights that changes in repertoire, venue, orchestral set-up and duration all impact significantly upon exposure. Further to this, it has been shown conclusively that exposure to orchestral musicians is highly localised, changing significantly from position to position and that many musicians are typically exposed to the highest sound levels from their own instrument (O'Brien, Wilson, & Bradley, 2008; Schmidt et al., 2011).

Safe Work Australia's Code of Practice recommends reviewing and revising control measures whenever there is a change to expected exposure that may affect workplace health and safety, (p.22, Regulation 38). As the nature of orchestral sound exposure is so variable, continued assessment of risk and ongoing adjustment of control measures is required to ensure controls in place are both effective and not unnecessarily restrictive to the musicians.

From a practical point of view it is clearly not feasible to monitor each musician in an orchestra in an ongoing fashion, however it is reasonable for an employee to expect that all risks to their hearing are properly monitored, documented and understood by the employer, and that suitable control measures are in place in time to protect their hearing.

In order to do this, an orchestra should have an ongoing sound monitoring program in place. Over time such a program will enable the development of a database of exposure which will allow more accurate predications of likely exposure for each position according to the variables of repertoire, venue, orchestral set-up and duration. Once developed and sufficiently detailed, such a database will lessen the requirement for ongoing monitoring and the program may be used to routinely review control measures and to assess the impact of significant changes in the workplace such as a reconfiguration of orchestral set-up.

Sources of orchestral workplace sound exposure

a) In the orchestra

The result of decades of research into the nature of orchestral sound exposure has shown that the obvious areas of high exposure – such as directly in front of the trumpet section – are not necessarily the areas of highest risk. In fact nearly all orchestral sound surveys show that the trumpet section itself (and the brass more generally) have by far the highest sound exposure profile in both pit orchestras and orchestras in symphonic set-ups and there are strong indications that they exhibit the highest incidence of hearing loss when compared to other sections of the orchestra (O'Brien, Driscoll, & Ackermann, 2013b).

Across the orchestra it has been repeatedly shown that the highest levels of exposure at the players' ears is usually due to the players' own instrument, with the exception of double bass, cello and harp. Violin and viola players show very high levels of exposure at the left ear (being closest to their instrument) and wind players, although regularly exposed to very loud peaks when the brass are at full fortissimo, are often exposed to moderately loud levels of much greater duration when the brass are not playing.

Clearly there is still a degree of risk of damaging exposure from instruments to the rear – particularly in loud tutti sections – but understanding the more subtle nature of orchestral sound exposure is vital in ensuring that control measures such as acoustic screens do not increase exposure for those already at the highest risk.

b) In private practice

The implications of this self-exposure are that louder instruments may also contribute to their daily sound exposure when in private practice. It has been shown that instruments such as the brass and percussion and some woodwinds are capable of generating sound levels outside the legislated limits while engaged in private practice and as such players need to be well educated regarding this risk to ensure good judgment is used during this practice (O'Brien, Ackermann, & Driscoll, 2013a).

16.4.2 Assessment of exposure

a) *How should monitoring be carried out?*

Sound level monitoring must be undertaken by suitably trained staff (see CoP 4.2, p.11). As the orchestra is highly variable sound environment hand-held devices are not recommended. 'Integrating' sound level meters (devices which record exposure over time) that are either mounted on a stand or worn on the musicians' body are the preferred.

The CoP stipulates: *"Noise measurements should be taken at 0.1 to 0.2 metres from the worker's ear canal entrance over a period of time that is representative of the noise produced during the tasks"* (p.12). Placing sound level more than 20cm away from the opening of the ear of the musician being assessed **will** give inaccurate readings.

b) Who should be monitored

All positions in the orchestra should be monitored with enough regularity to enable informed decisions to be made regarding potential risk for any playing position in any venue in the most common orchestral configurations.

c) When should monitoring occur?

Monitoring should take place during rehearsals, performances and (for some instruments) during private practice to enable informed decisions to be made regarding potential risk for any type of program in any venue.

d) Where should monitoring occur?

Monitoring should be undertaken at all performance and rehearsal venues and in individual practice facilities.

e) What should be monitored?

All repertoire types and styles should be monitored with enough regularity to enable informed decisions to be made regarding potential risk for any type of program in any venue. Monitoring of only repertoire considered 'loud' (such as amplified events) is not sufficient to enable a comprehensive hearing conservation strategy to be developed.

16.4.3 Audiological monitoring

Audiological monitoring (including baseline testing within 3 months of commencement of employment) involves regular hearing testing or screening by appropriately qualified professionals to ensure that any changes to an individual's hearing are noted early and acted upon.

If employees are required to wear hearing protectors as a control measure for sound exposure, then their employers are obliged to provide this testing every 24 months (although this varies from state to state), with more frequent testing recommended for those in moderate to high sound exposure workplaces.

Most audiologists recommend annual hearing testing to monitor hearing health.

i. **The benefits of audiological monitoring?**

Audiological monitoring benefits the musicians in several ways besides ensuring damage to the hearing is not occurring as a result of workplace sound exposure. Regular contact with a hearing professional helps re-enforce broader training and education and to remind employees that their hearing is precious and that hearing damage from sound exposure usually permanent.

Secondly, this is a chance for players to check the performance of their hearing protectors, to receive one-on-one training and guidance and to discuss their management strategies regarding sound exposure.

Thirdly – and not related to sound exposure – general hearing and ear health should be a priority for all musicians who rely on this sense for their livelihood.

16.5 Control strategies and the hierarchy of controls

Control measures must be implemented according to a hierarchy. Some control measures that are available to industry (such as the elimination or substitution of the hazard) are simply not practical in an orchestra without fundamentally re-imagining what an orchestra is and does. Other control measures must be carefully balanced in order to avoid artistic damage or unnecessary financial burden on the organisation.

According to Safe Work Australia (and mirrored in the various State-based guidelines), the hierarchy of controls is as follows:

- *Eliminate (remove) the risk*
- *Minimise the risk through substitution, modification or isolation*
- *Use administrative controls such as forward planning, rostering and job-sharing*
- *Provide suitable personal protective equipment for use.*

The hierarchy requires administrative and personal protective equipment to be used only after elimination and minimisation strategies have been implemented and found to be insufficient. It is arranged in this manner due to the fact that both administrative and personal controls tend to be the least effective due to their reliance upon supervision and human behaviour.

16.5.1 Eliminating the risk

Risk elimination in an orchestra is perhaps the least practical approach except in extreme circumstances where artistic changes in orchestral arrangement can be negotiated, such as a reduction in brass strength in very large orchestral scoring.

16.5.2 Minimising the risk through substitution

Substituting louder instruments or orchestral passages for quieter ones will clearly damage the music/alter being created to such an extent that it is not generally a useful control measure for orchestras.

16.5.3 Minimising the risk through modification

Sometimes referred to as 'engineered controls', applied correctly modification to the orchestral working environment is one of the most reliable and effective long-term control measures. Even if such measures do not completely achieve compliance, they should still be routinely implemented to reduce dependence upon administrative and personal control measures. Care must be taken, however, to ensure that implemented controls do not increase risk levels to players of high risk in order to reduce exposure to players of moderate or lower risk.

In an orchestra, controls achieved through modification can be quite varied and often need to be developed specifically for individual orchestras or even for specific venues or programs.

16.5.4. Acoustic treatment

Acoustic treatment generally involves absorptive or diffusive material. Absorptive material literally absorbs sound energy while diffusive material literally scatters or breaks up the sound while maintaining a 'live' acoustic environment. The temptation – particularly in orchestra pits – is to using highly absorptive material to reduce sound levels, however the end result is simply a loss of resonance and quality rather than volume attenuation. This is often perceived by the musicians as a lack of projection into the performance space and may actually contribute to higher sound levels at the source and ultimately lead to strain and overuse injuries. It is for this reason that diffusive material is much preferred as an acoustic treatment.

1. Screens and deflectors

a) Sectional screens

There are many styles of sectional screens or baffles in use in orchestras. Often they are arranged as vertical Perspex sheeting placed around drum kits or in front of brass sections. Screens arranged in this way are largely counter-productive – while to some extent they reduce sound for musicians 'in the line of fire', they tend to reflect sound directly back to players of the louder instruments, who are usually in a higher risk category than those directly in front of them.

A solution are screens configured with a combination of deflective and diffusive material (Figure 6), which have been shown to reduce sound levels by as much as ten times with negligible impact on players 'upstream' (O'Brien, Wood, & Ackermann, 2013c).



Figure 8. A deflective/diffusive screen in use in a professional orchestra

These screens have also been successfully used to protect players adjacent to drum kits while avoiding enclosing the drummer in a 'sonic cage'.

b) Personal screens

There are several styles of personal screen in use in Australia's orchestras. Perhaps the most common style seen today is the wrap-around acoustic screen from Goodear (Figure 7). This screen has undergone field and laboratory testing and has been shown to reduce adjacent sound exposure by as much as 80% under laboratory conditions (Williams & Stewart, 2011). There are some minor problems with these screens such as a 'wall of foam' effect when many are lined up directly in front of a brass section and sight line issues. For this reason they are most effective if the stage is raked or staggered between orchestral rows.



Figure 9. Goodear's absorptive personal screen.

Other common personal screens in use are flat Perspex sheeting attached to a stand. This style of screen – while having been used for many years – has repeatedly been shown to be either ineffectual or counterproductive in attenuating sound levels (Libera & Mace, 2010). (Figure 8).



Figure 10. A variety of Perspex screens.

16.5.5. *Orchestral set-up*

The way an orchestra is set up is a powerful tool in sound exposure mitigation as long as high level programs are identified with appropriate forward planning to ensure that proposed layouts are artistically functional for the musicians and the conductor. Some simple options and their rationale are identified below, but there are many variations possible within any orchestra.

i. Spreading high level instruments out

This is a particularly useful technique for smaller venues or in orchestra pits. Often the temptation (and the conductor's wish) is for all of the louder instruments to be located in one place. This has the effect of exacerbating exposure for players already at high risk. Placing the horn section, for instance, to the left of the wind section and the remainder of the brass to the right can enable the horns' sound to travel directly out to the audience rather than into other musicians and allow the brass to minimize ranking.

ii. Avoiding ranking high-risk instruments

Ranking of brass sections is very common and is often used to keep the brass players compact and in close contact. However it is very unfavorable to exposure levels for these players of high-risk instruments and should be avoided where at all possible.

iii. Using distance between players as a control measure

Distance is one of the most effective attenuation tools. For every meter you travel from the sound source, exposure falls by roughly half, depending upon the nature of the source. If there is space, placing instrument rows further apart is an ideal attenuation tool with low artistic impact. For instruments such as the brass – particularly the horns - distance between players is also critical in limiting exposure levels.

iv. Using height between rows

In his 1996 book 'Musicians and the Prevention of Hearing Loss', (Chasin, 1996) Canadian Audiologist and musician Marshall Chasin pointed out that height between instrument rows was a very effective way to not only reduce exposure to those in front of high level instruments, but was also a way to allow the sound of instruments like the trumpet to travel directly to the audience without having to blast through other musicians. With this in mind, raking an orchestra steeply towards the rear is yet another option for exposure reduction and increased comfort for the musicians.

16.5.6 *Minimising the risk through isolation*

Similar to elimination and substitution, isolation is quite impractical in an orchestra except in some extreme circumstances, such as during productions in small pits with very large orchestras. In this instance the removal of orchestral sections to separate areas and linking these sections back to the orchestra using video and audio technology may be an option.

16.5.7. Administrative controls

Like controls through modification, administrative controls are many and varied, and may often be developed for particular events if identified in advance. Administrative controls are less favoured than elimination or minimization controls and as such must only be considered after the implementation of these measures.

i. Rostering

Rostering according to exposure can be an effective tool either during ballet or opera seasons. Typically more than one player in confirmed high-risk areas will cover a single part and split the performances. This is particularly useful when there is more than one performance in a 24-hour period.

There is no provision in the National Code of Practice to “average out” exposure the course of a working week, for example, with limits set to an equivalent of an 8-hour work shift. This means that if exposure control using modification and rostering is unable to reduce sound exposure *in a single working day* to below allowable daily limits, then further controls must also be implemented.

While useful, relying upon rostering to manage exposure may cause artistic problems due to constantly changing personnel and may also become financially burdensome.

ii. Rotation

Rotation may be used effectively in the string sections by organising those on the rear few desks to regularly alternate who sits in the most exposed positions.

It may also be used for programs that can be ‘shared’ between players, a practice that is already in place for other reasons within many orchestras. A typical example may be having associate principal wind and brass players give respite to their colleagues for the first half of an evening performance, and then being given respite in return for the second half. Such approaches should be discussed with those responsible for sectional rostering to ensure that sound exposure is a consideration during their planning stages.

iii. Low level warm-up

Sound levels during pre-call warm-up periods have a tendency to become very high, particularly when there is a large orchestra preparing to play a high-level work. Having agreement among the players to limit their volume during warm-up periods will reduce overall exposure during the working day.

iv. Enforced quiet breaks

Orchestras have regular breaks, and this is a critical time to rest the ears and reduce average exposure levels. Sectional practicing, particularly amongst high-risk players, should be actively discouraged.

v. Quiet zones

Similar to other high sound level workplaces, ‘quiet zones’ for players to congregate are essential. If the orchestra’s green room is particularly noisy, then a low-level area should be set aside which is free of instrumental playing and large numbers of people.

vi. Reminders, signage and communication

Musicians should be aware of their risk on a program-to-program basis and be informed as to their obligations regarding hazard management for each program. This can be achieved in various ways: through alerts in printed rosters, email and on-line roster updates, or simply through written alerts placed on music stands and re-enforced with announcements.

vii. Planned scheduling of rehearsals to spread out louder repertoire and venue-sensitive rehearsal planning

This control can significantly impact the need for other controls, but must be worked into the orchestra’s roster during planning phases and also be discussed with conductors. Rehearsing large-scale works only in appropriately sized venues should also be routinely considered.

viii. Planned scheduling of performances to spread out louder programs

This control may be considered if there is a possibility of reducing the number of performances per day in repeated programs is an option. It may also be considered for particularly loud repertoire if holding the dress/general rehearsal the day prior to a performance is possible.

ix. Planned repertoire programming to avoid programs that are ‘all loud’

This is a very important control and should be discussed with an orchestra’s artistic department and highlights the need for involvement of artistic programmers in hearing conservation management processes.

x. Under-volume rehearsals

There are many occasions when rehearsing “under volume” or within the limits of the rehearsal venue are an option for exposure control, however this must be directed by the conductor and insisted upon by the players. Such an approach requires a comprehensive education strategy in place.

16.5.8 Personal controls

Earplugs and other personal hearing protectors are the very last step in exposure management plans for any industry. Simply mandating the use of hearing protectors without instigating a monitoring program, implementing the controls such as those outlined above and providing comprehensive induction, education and training does not comply with the Code of Practice.

If, however, there is still risk of exposure to hazardous levels of sound after the implementation of other controls, then adequate personal hearing protection must be provided and used.

Despite controls outlined above, it is highly likely that some musicians' exposure will remain too high for much of the larger orchestral repertoire. As such, these players need to be identified and they *must* use hearing protectors.

For orchestral musicians, the only really feasible personal control is the use of earplugs. While in-ear monitor technology similar to that being used by many in the pop music genre holds some future promise, particularly with the development of 'ambient' in-ear monitors, earplugs are the simplest and most reliable personal control in this environment.

The amount of attenuation these players will require will be dictated by the effectiveness of other control measures higher up the hierarchy. As technology has yet to evolve to a point where players are completely comfortable wearing earplugs, the lighter the attenuation required the more likelihood there will be for compliance by the musicians.

i. Passive Earplugs

Passive earplugs are those, which do not require electronics or active circuits in order to function. There are two distinct styles: those able to fit various ear shapes (generic) and those which are fitted to individual ears by an audiologist (custom moulded).

a) generic passive earplugs

Generic earplugs are many and varied, with the most familiar being the foam style used in many industrial settings. (Figure 9)



Figure 11. Generic foam earplugs

These earplugs, although effective attenuators when correctly inserted, are not recommended for orchestral players as they significantly alter the incoming sound spectrum and radically over-attenuate, making interaction with other players very difficult. Many musicians are permanently dissuaded from using hearing protection due to bad experiences with these and similar earplugs. They are useful,

however, in lieu of more appropriate hearing protectors and employees should be trained in their usage.

A preferred style of generic earplug is those that contain a ‘musicians’ filter (Figure 10 – with flanges), which aims to have limited impact on the incoming sound spectrum. Although these earplugs attenuate too much for most orchestral situations, they do so evenly within the hearing spectrum and as such are more usable for musicians.



Figure 12. Musicians’ earplugs – various styles and manufacturers

b) Custom moulded passive earplugs

Fitted earplugs are generally preferable for orchestral musicians. The attenuation these earplugs offer can be altered and they can be manufactured to overcome a problem known as ‘occlusion’, or an overabundance of internal sound. Occlusion can prevent a musician hearing anything but the sound of their reed, mouthpiece or strings, and is a significant problem for this population. It can be overcome with a specific style of mould manufacture, and as such it is important to engage an audiologist who is experienced with the needs of musicians of various instruments. Appendix 1 outlines those players for whom occlusion may be an issue.

There are many manufacturers of fitted “musicians” earplugs (see Figure 10). While several of these pride themselves on the quality of their filters and the fidelity of the sound the musician receives, some variety use generic hearing aid filters which have poor responses and alter the incoming sound spectrum.

ii. Active earplugs

Active or electronic earplugs (Figure 11) have only been developed in the last few years and are gaining popularity and acceptance with some orchestral musicians. Research has shown that musicians

generally prefer this style of earplug to passive earplugs (O'Brien, Driscoll, Williams, & Ackermann, 2014b).

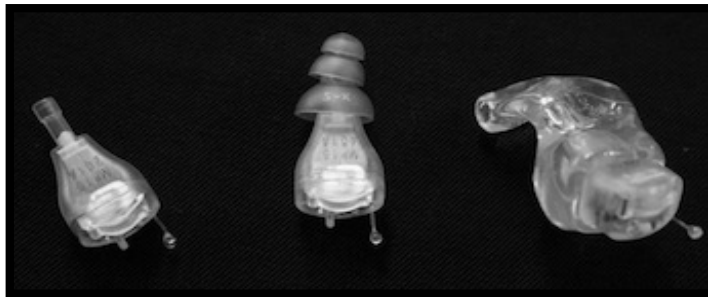


Figure 13. Active earplugs (L to R: no ear tip, generic tip and custom fit)

The earplugs run on a hearing aid battery and have a switchable attenuation. They also slightly amplify low-level sound, enabling communication with others quite easy. Those wearing active earplugs suffer the same problems with occlusion that those wearing passive earplugs experience, and as such a custom moulding is required for players of affected instruments.

iii. Earplug compliance

Compliance with earplug directives is a problem in many industries and none more so than in orchestras, where there has been an entrenched attitude that 'earplugs are impossible to play with' for many, many years. Despite this as many as 63% of Australia's orchestral musicians use earplugs at least some of the time (O'Brien, Ackermann, & Driscoll, 2014a).

Given correct attenuation, fitting and earplug style, it is now easier for musicians to work at capacity with earplugs, although players must take time to adjust to the alteration of perception that inevitably occurs with earplugs in place.

Ultimately, cultural change can only occur when the players firmly believe that it is in their best interests to wear hearing protection when required, and education and training are critical in this regard.

It is within an employer's rights to insist that workers wear appropriate protective equipment.

a. Special note: Private practice

While often taking place beyond the orchestral workplace, private practice is required in order for musicians to be prepared for the artistic challenges they face and to maintain proficiency on their instrument.

It has been conclusively shown that private practice contributes significantly to many musicians' exposure levels – particularly amongst those playing high level instruments – and as such it must be considered when determining both control measures and training advice (O'Brien et al., 2013a).

b. Induction, education and training

16.7.1 Musicians

At commencement of employment all musicians should be made aware of hazards in the workplace as well be provided with protective equipment and informed as to appropriate hazard management strategies. This training should be regularly re-enforced through communications from orchestral management and ongoing training and education measures.

Casual, short-term and long-term contract players should also be given induction training and have this training re-enforced regularly while performing with an orchestra.

i. Non-musician staff

For hearing conservation to be appropriately addressed at all levels of the organization, it is equally important for support staff, artistic staff and managers to be regularly made aware of the problems surrounding hearing conservation for orchestral musicians and appropriate strategies for sound exposure management.

ii. Conductors

Conductors often have a critical role to play in re-enforcing control measures and the decisions they make regarding rehearsal technique and orchestral layout can significantly affect exposure levels. A poorly informed conductor can undermine a well-devised exposure management plan in the course of a single rehearsal. For this reason, conductors should be properly informed as to relevant elements of an orchestra's hearing conservation strategy as a part of their standard workplace induction procedure.

16.8 Conclusion

Although initially an approach such as that described here may be onerous to develop and implement, it has been observed that such practices soon become part of the daily operations of an orchestra. Some orchestras may face greater cultural resistance than others in instigating a comprehensive strategy, however – legal obligations aside – it is imperative for the continued success of an orchestra that the ears of its musicians remain in the best possible health. This may require the development of new skills by the musicians together with a degree of understanding from management as all adapt to more robust approaches to hearing conservation for the industry.

16.9 Chapter Summary

1. Orchestras should develop comprehensive, bespoke hearing conservation strategies in order protect the musicians' hearing and facilitate compliance with legislation
2. Such strategies need to be evidence-based and carefully adapted, implemented and maintained to maximize acceptance and uptake while minimizing artistic impact
3. Orchestras should charge a small group made up of key internal stakeholders with managing, implementing and auditing their hearing conservation strategy
4. All orchestras should have ongoing sound and audiological monitoring programs in place
 - a. Monitoring programs must be supported by practices which use the data gathered to implement considered, effective control measures and to provide the basis of adequate education and training for the musicians and their operational staff
 - b. Controls should be implemented according to a hierarchy, with personal controls mandated in addition and subsequent to the implementation of all other available controls able to be implemented in a reasonably practicable manner
 - c. Personal controls should of a quality appropriate to the industry
 - d. Risks, expectations and obligations must be clearly communicated to the musicians on a program-by-program basis
 - e. Ongoing education and training of all orchestral staff and musicians and comprehensive induction of new staff is required

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CHAPTER 17: DEVELOPMENT OF MUSCULOSKELETAL HEALTH STRATEGIES

17.1 Introduction

As discussed previously, professional orchestras are bound by Work Health and Safety regulations as stipulated by the Safe Work Australia (2011) Code of Practice to provide safe working environments for all musicians. This includes the area of physical and psychological health and well-being. Workplace modifications, injury prevention models and pathways and risk management strategies need to be identified and implemented.

These strategies include:

- Nomination of key staff to oversee the successful operation and resourcing of the program
- Formation of a working group/ committee with representatives from musicians and management
- Development of targeted control strategies according to the hierarchy of controls
- Implementation of an injury management plan
- Ensuring training and education programs at induction and regularly thereafter

This chapter examines the strategies required for optimising physical and psychological health and well-being.

17.2 Hierarchy of controls

According to Safe Work Australia (and mirrored in the various State-based guidelines), the hierarchy of controls is as follows:

1. *Eliminate (remove) the risk*
2. *Minimise the risk through substitution, modification or isolation*
3. *Minimise the risk through engineering controls*
4. *Use administrative controls such as forward planning, rostering and job-sharing*
5. *Education and training*
6. *Provide suitable personal protective equipment for use.*

This hierarchy provides a guide for the development and implementation of control measures, starting with elimination and only using personal protective equipment when other measures do not provide adequate control of the relevant hazard.

17.2.1 Eliminating the risk.

This is the least probable within the working of the orchestras and the very nature of being a professional musician, due to the unique workload and biomechanical impact that playing at an elite level creates.

17.2.2 Minimising the risk through substitution, modification or isolation

Substituting instruments or orchestral passages for lighter or modified ones may clearly damage the music being created to such an extent that it is not likely to generally be a useful control measure for orchestras. It is not possible to isolate the musician from the hazard of playing their instrument, and instead requires better use of effective practice strategies to reduce single exposure times for more strenuous repertoire.

17.2.3 Minimise the risk through engineering controls

Management needs to provide appropriate ergonomic equipment that provides best support and reduces injury risk. In addition, adequate ventilation and appropriate lighting is needed.

17.2.4 Use of administrative controls

Administrative controls need to involve the artistic directors, conductors, and management in the planned scheduling of rehearsals and performances and understanding of whether the workload constitutes high/medium/low load and what areas of the orchestra may be vulnerable with each specific repertoire. Provision of medical staff and triage facilities may facilitate this control.

17.2.5 Providing suitable personal protective equipment

Management needs to provide appropriate equipment that provides best support and reduces injury risk. This includes ergonomic chairs, adjustable music stands, and lights for the stands in dim lighting conditions such as in orchestra pits.

17.3 Musician Health Committee

The role of a musician health committee (MHC) is important, and should include analysing whether scheduling or other orchestra specific issues are related to any notable surges in injury reports. The committee should include representatives of musicians, artistic departments and management. They will play a pivotal role in data collection, education and liaison roles between all members and maintain regular WH&S updates and in-services.

17.4 Injury Management Pathways

The Sound Practice Project has developed an injury management pathway that could be utilised by orchestras to direct appropriate options for any injured musicians. The development of an injury management pathway is one of the key conclusions to be practically drawn from the research. This gives advice and a structured response for musicians, management and health professionals to follow or use as a guide in responding to the injured musician. An example of one approach to injury management is in Appendix 6.

17.5 Education Strategies

Musicians and management need to be educated and informed of the potential injury risks and approaches to injury management. All parties need to understand and be fully informed of the pathways for injury management as well as of the workers compensation process and return to work pathways. The Musician Health Committee should play a pivotal role in maintaining the education of musicians and management

17.6 Workers Compensation pathways

Comcare has devised a four-factor model of optimal return to work (Figure below). Use of this model provides a good starting point to enable musicians and management to ensure that all four factors are being considered in the return to work process for injured musicians.

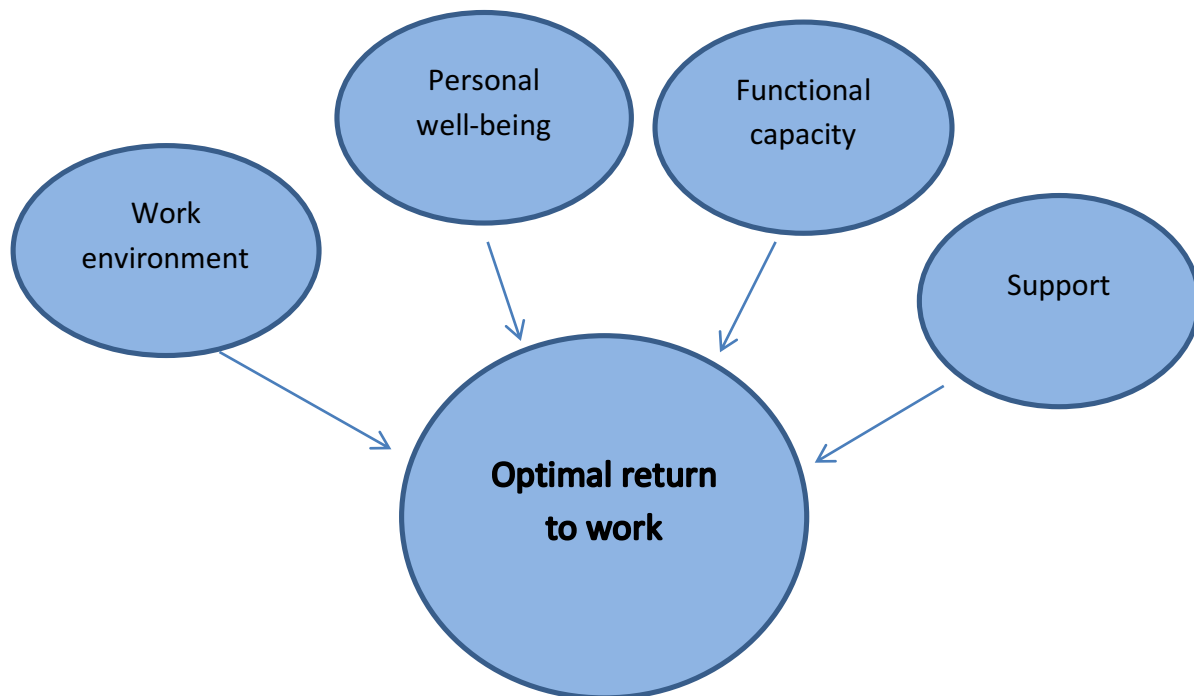


Figure 14: Four Factor Model of Optimal Return to Work* (Comcare)

*Comcare Four Factor model of optimal RTW www.iscrr.com.au/news/events/achr-forum-posters/poster-5-achrf13.pdf

Work Environment refers to the way in which an individual interacts with and feels about their workplace, including their relationship with their manager.

Personal well-being refers to how an individual perceives themselves, including their level of self-esteem, self-concept, and locus of control.

Functional Capacity refers to the way in which an individual perceives their injury and their capacity to do their job.

Support refers to an individual's perception of the support available/accessible to them.

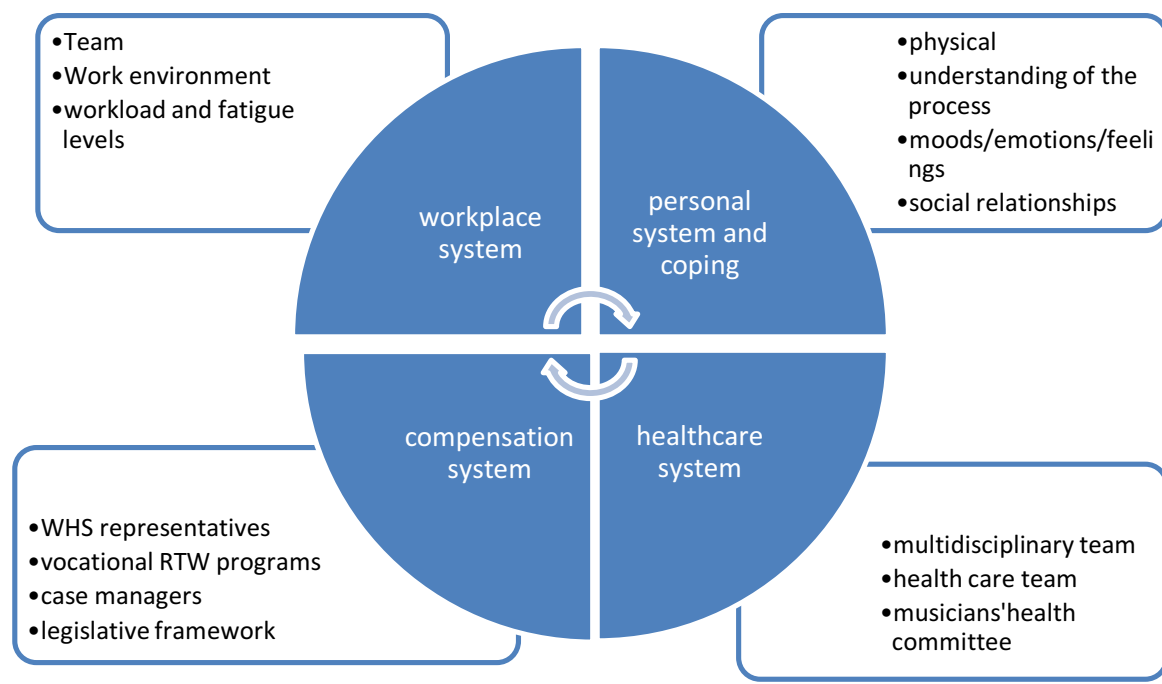


Figure15: Interwork Revised pathways to work projects* (with adaptations for Sound Practice Project)

*WorkcoverSA www.workcover.com/upload/custom/files/Interwork_executive_summary.pdf

17.7 Conclusions

Risk management and WHS strategies should be customised to specifically address orchestral demands to adequately cover both physical and psychological injuries and their prevention and management. More attention to ranking intensity of different programs at the beginning of the year may assist planning of the year ahead.

CHAPTER 18 - FUTURE RECOMMENDATIONS AND OUTSTANDING QUESTIONS

18.1 Introduction

In general terms the professional orchestral musician remains susceptible to a range of workplace health and safety risks due to their repetitive and intensive workloads, but exposures do vary between orchestras and instruments.

Several specific recommendations for orchestral WHS, musician injury prevention and management and future research directives can be drawn from the Sound Practice Project.

18.2 Workplace Health and Safety recommendations

Based on the findings from the Sound Practice Project the following recommendations have been made to enable orchestras to maximise the health and safety of their respective musicians.

- Establishment of a Musicians' Health Committee (MHC)
- Establishment of a formal triage system for each orchestra
- Facilitate access to appropriate health professional input and treatment as required following the injury management pathway (Chapter 16)
- Formal management of noise issues
- Formal management of manual handling
- Initiate running of the surveillance system across all orchestras
- Regular use and reporting of data (to MHC)

18.3 General health recommendations

- i) Education- including physical, psychological and audiological health
- ii) Injury prevention education for musicians
- iii) Ergonomic assessment and applications as appropriate
- iv) Establishment of appropriate nutrition and hydration practices amongst musicians.
- v) Addressing muscle conditioning and flexibility
- vi) Assessing and retraining postural faults within the musicians
- vii) Identifying and correcting biomechanical flaws
- viii) Retraining appropriate motor control strategies
- ix) Applying therapeutic interventions as appropriate for injury prevention and management

18.4 Outstanding questions from the Sound Practice Project

The Sound Practice Project has implemented and tested a large range of novel and targeted interventions that have received international attention. However, in this new field of research much more clinical and research work is yet to be done in continuing to improve instrument and orchestral workplace specific demands on the human body. Part of these studies should incorporate physiological testing, such as using muscle activity research to determine safe playing loads. It is also clear that engaging in better understanding the factors that may cause a musician to avoid reporting an injury is crucial in encouraging an earlier and easier pathway to recovery.

18.5 Future Research directions

- i) Refining models of musculoskeletal examination to include instrument specific evaluation
- ii) Further exploration of the complex relationship between psychological health and physical factors.
- iii) Continuing to explore effective ways of protecting hearing without damaging the ultimate performance goal of beautiful music production
- iv) Further trial and modification of on-line approach to musician surveillance
- v) Longitudinal tracking of entry level musicians to assess causal mechanisms for physical and mental health concerns.

CHAPTER 19: CONCLUSIONS

The University of Sydney team has presented the results of the Sound Practice Project nationally and internationally at health professional and music-health related conferences, and this is leading to international endeavours to improve musicians' health. Publications have facilitated spreading the word regarding results, and all publications acknowledge the ongoing support of the Australian government and the orchestras in the Project. In addition, musicians have been encouraged to participate in this process and liaise with Dr Ackermann to develop manuscripts for the specific musicians' journals or conferences.

Future collaborations with international partners have been initiated to further the knowledge and expertise gained as a result of this project. We have received reports of improving health culture in the high participation orchestras. It is hoped that ongoing work can continue with the orchestras to build on the substantial base of work already completed and encourage healthy practice within the orchestral workplace.

Recommendations for future research directions drawn from the Sound Practice Project of trials include:

- Refining models of musculoskeletal examination to include instrument-specific evaluation
- Further exploration of the complex relationship between psychological health and physical factors.
- Continuing to explore effective ways of protecting hearing without damaging the ultimate performance goal of beautiful music production
- Further trial and modification of on-line approach to musician surveillance
- Longitudinal tracking of entry level musicians to assess causal mechanisms resulting in physical and mental health concerns

1. Summary for Musicians

Professional orchestral musicians need to be aware that playing music at an elite level creates a risk of over-use injuries as in other elite performance domains. They require basic knowledge of relevant health related topics and an understanding of the particular stressors associated with playing their specific instrument. Musicians need to be aware of the importance of early assessment and injury management, as well as engaging in preventative measures as part of their individual self-management program. As part of this self-management all professional orchestral musicians need to have developed their own pre- practice routine including warm-up, psychological preparation, and an adequate hydration and nutrition plan. They need to have an ongoing fitness plan that incorporates cardiovascular exercise and specific core strengthening exercises and to have a working knowledge of their postural and biomechanical requirements.

2. Summary for Management

Management need to take an active role in injury prevention and risk management issues. The WHS Act and recommendations from the Sound Practice Project should become a guideline for management directives in regards to the injured musician. Ergonomic considerations including workplace set-up, repertoires, scheduling and touring requirements, noise levels and other environmental stressors need to be analysed and recommendations followed through. There needs to be consideration of sectional loads when planning repertoire schedules, rehearsals and player rotations. For example, if rehearsals and performances are on the same day, section leaders should be able to reduce intensity of appropriate sections during rehearsal if deemed necessary. A formal pathway of injury management utilising health care providers including rehabilitation providers, general practitioners, allied health practitioners, audiologists and psychologists needs to be established and followed. There needs to be promotion of a positive health culture including formal and informal mentorship by section leaders and for all new musicians.

3. Summary for Health Professionals

Therapeutic management of the injured musician should encompass a holistic and multi-disciplinary approach. This includes medical, allied health, auditory and psychology health professionals, as appropriate. Good communication between musician, teacher, health professionals and music administration is required. Any therapy needs to take an active approach in addressing the relevant risk factors and modifying these when able. Health professionals therefore need to be adequately trained in understanding the specific needs and requirements of elite music performers. The phenomenon of the musical athlete needs to be more widely discussed and taught at undergraduate and post- graduate levels. Clinical management needs to aim for full functional recovery and careful planning and monitoring of return to playing and performance.

Appendix 1: Strong Orchestra Review Report (2005)

Available online December 2016 at: <http://www.agsm.edu.au/bobm/teaching/SSO/strongreport.pdf>

Appendix 2: Sound Practice Milestones

SOUND PRACTICE PROJECT MILESTONES

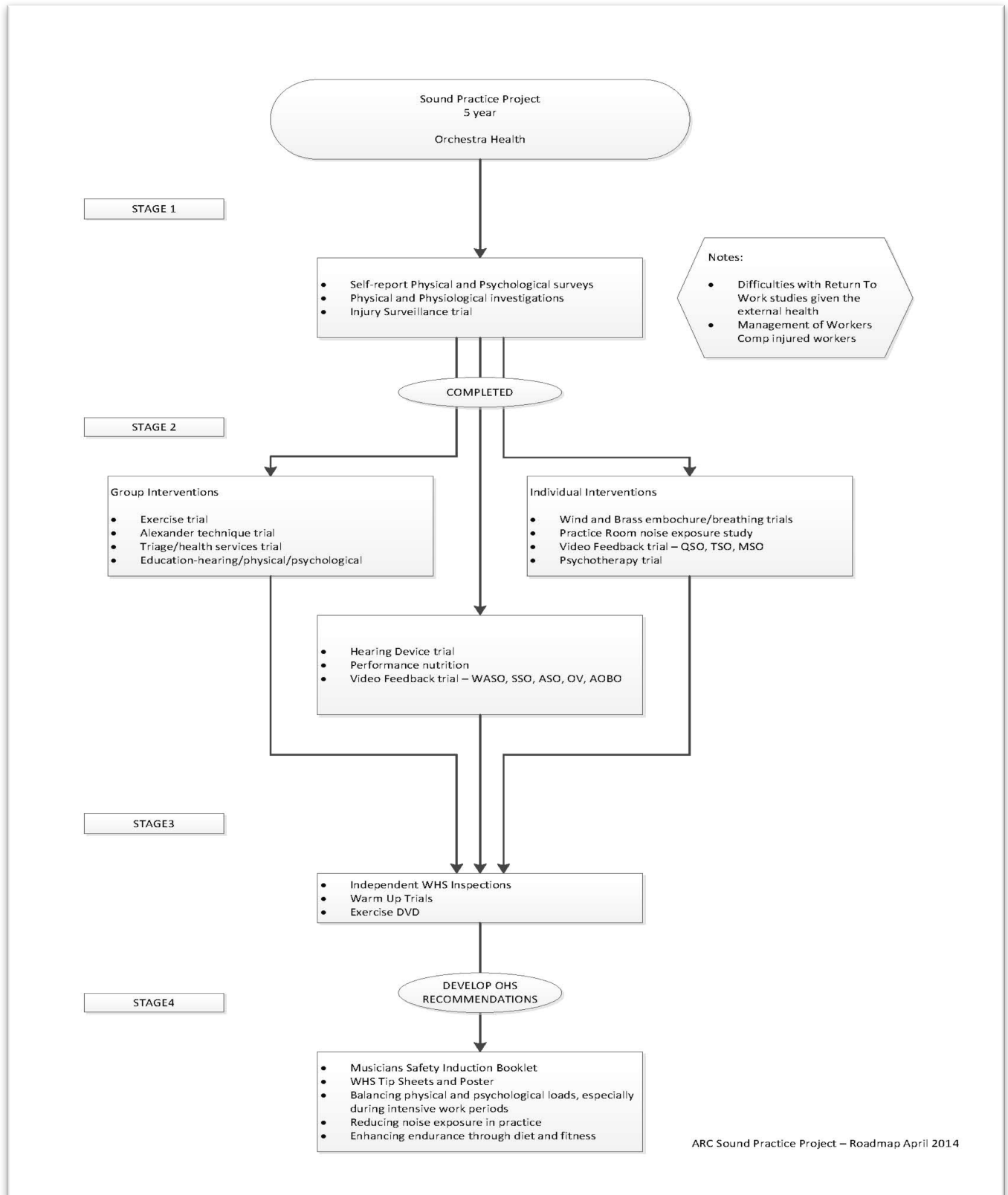
PROJECT PHASE	2009		2010		2011		2012		2013		2014	
	YEAR ONE		YEAR TWO		YEAR THREE		YEAR FOUR		YEAR FIVE		CONSOLIDATION	
	0-6 months	6-12 months	12-18 months	18-24 months	24-30 months	30-36 months	36-42 months	42-48 months	48-54 months	54-60 months	60-66 months	66-72 months
Collate baseline data (premiums, DALYs)	X									X		
Comprehensive health assessment	X									X		
Establish and run injury surveillance system		X	X	X	X	X	X	X	X	X		
Feedback-based intervention trials		X	X	X	X	X						
Surveillance-based targeted intervention trials				X	X	X	X	X	X	X		
Draft OH&S procedural document								X	X			
Trial OH&S procedures									X	X		
Review and finalise OH&S policy										X	X	X

Appendix 3: Sound Practice Project matrix

SOUND PRACTICE PROGRAM MATRIX

	Baseline Assess	Exercise Trial	Alexander Trial	Triage Trial	Health Educ	MPA Educ	MPA Trial	Wind & Brass	Video Feedback	Hearing Review Initial	Hearing Device Trial	Intensive Recovery Triage Trial	Nutrition Survey	Exer DVD	WarmUp Trial
QSO	May-09	18 May 10 - 22 Jul 10 & 19 Aug 10 - 20 Oct 10	4 Mar 11 - 11 May 11	10 Feb - 2 Jun 2011	DONE 2-5 May 2011	16-Nov-10	NA	DONE 2nd 5 May 2011	16-May-12	DONE	DONE	NA		23-Mar-12	3-Mar-14 & 3-Apr-14
ASO	Jun-09	20 Jul 10 - 23 Sep 10	23 Feb 11 - 9 Jun 11	9 Feb-15 Jun 2011	14-Jul-10	9-Aug-11	NA	DONE	3-4 Jul 13	29-Sep-11		NA		20-Jun-12	8-May-14
MSO	Apr-09	14 Sep 10 - 10 Nov 10	11 Mar 11 - 14 July 11	2 Aug 11 - 8 Nov 11	DONE	14 Mar 2010 - 8 Mar 2012	Aug-Dec 10	20-22 Oct 2010	8-Mar-12	30-Aug-11		NA		8-Mar-12	
TSO	May-09	24 Mar 11 - 20 May 11	23 Jun 11 - 19 Aug 11	12 Jun 11 - 27 Oct 11	DONE		NA	DONE	DONE			NA	20-Aug-13	2-May-12	
SSO	May-09	23 May 11 - 6 Sep 11	21 Feb 11 - 17 May 11	1 Jul 10 - 12 Aug 10	DONE		NA	DONE		9-Sep-11		NA		21-Mar-12	
OV	Jun-09	NA	7 Apr 11 - 21 Jul 11	7 Mar 11 - 20 Jun 11	2-Feb-12		NA			31-Aug-11		NA		2-Feb-12	
AOBO	May-09	17 Jan 11 - 16 March 11	#1. 11 Aug 10 - 1 Oct 10 #2. 15 Feb 11 - 29 Apr 11	28 Jun 11 - 5 Oct 11	DONE		NA	DONE		7&8 Sep 11	7&8 Sep 11	Jun-Aug 13	28-Jun-13	8-May-12	
WASO	May-09	29 Sept 10 - 1 Dec 2010	4 Oct 11 - 1 Dec 11	9 March - 6 July 2011	28-Sep-10		NA	24-25 Feb 2011	DONE	30-Sep-11		NA	23-Jul-13	9-Mar-12	1-Jun-14

Appendix 4 : Sound Practice Project Flowchart



Appendix 5: Project management

Project Management

The complex and unique administrative demands of the Sound Practice Project required a full time project manager. This role was necessary to manage the project logistics, organisation of travel requirements for the large group of health professionals that did the initial baseline testing and communicate, liaise and organise meetings with the partner Orchestras, musicians and associated staff. The project manager and the project leader (BA) met weekly for the 5-year duration of the Sound Practice Project.

The project manager was on hand to administer the initial physical and psychological surveys and then assist in its administrative data collation. (See Appendix 2 Sound Practice Project Timeline and Flowchart)

Project Communication

Over the duration of the project, over 15 training and education sessions were conducted for partner organisation management and musicians. Topics included as exercise, posture, general health, nutrition and updates on latest results from the study. Regular communication was actively encouraged to facilitate teamwork and deal with any potential issues or difficulties.

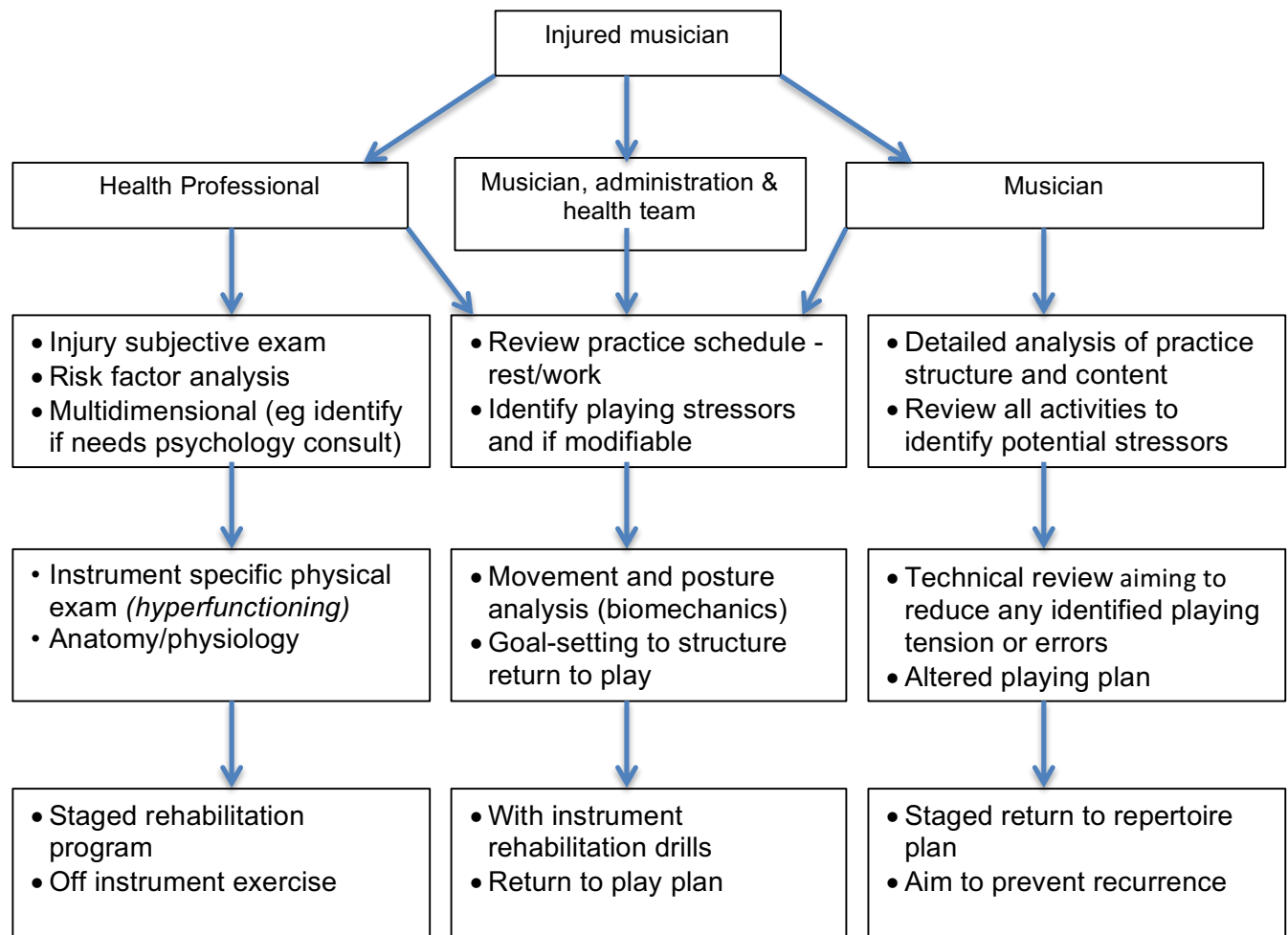
Formal scheduled project facilitated meetings with our partner organisations in the form of CEO Updates were held on Dec 2009, Aug 2010, Nov 2010, Dec 2010, Mar 2011, Mar 2012, Aug 2013, Nov 2013

Formal group liaison Officer meetings were also held (2010 x 4, 2011 x 4, 2012 x 2, 2013 x 2) which informed the partners of the project's current and upcoming research trials and assessments. Collaborative communications with partner organisations and the project team streamlined the scheduling and increased buy-in with the major stakeholder groups of the project. The partner organisations participated in over 118 intervention trials with over 400 voluntary participants around Australia between 2009 and 2014.

1.7 Ethics Approval

Human research ethical submissions were made and subsequently approved for each of the project's trials by the University of Sydney ethics department.

Appendix 6: Injury Management Pathway Example



Appendix 7: CEO report from November 2012

CEO report – Sound Practice Orchestral Health Program

Sound practice: Supporting sustainable careers in orchestral musicians through the development, implementation and evaluation of industry-specific occupational health and safety practices

Background

The Sound Practice Project answered the call from the government-commissioned Strong report (2005) for the development and implementation of the first-ever national occupational health and safety policies and practices for orchestral musicians. A team of University of Sydney academics led by Dr Bronwen Ackermann were successful in receiving substantial additional funding from the Australia Research Council Linkage Scheme (\$735,000) to boost the cash and in-kind contributions from the Australia Council for the Arts and the 8 major orchestras of Australia to allow a truly comprehensive project to be undertaken – the first of its kind internationally. With the recent introduction of the new harmonised Work Health and Safety Act (2012), the information from this study will help develop guidelines for work health and safety within the orchestral environment.

As the first step in this project, a baseline evaluation was required to establish a national database of the physical and psychological characteristics of the musicians so that further assessments and interventions could be targeted to specifically meet the needs of the Australian orchestral musicians. The first series of evaluations took place in the form of a self-report survey evaluating demographics information, pain profiles and physical and psychological characteristics of the musicians as well as a thorough physical examination completed by a team of trained and experienced physiotherapists across the country.

From this baseline information, additional assessment protocols were developed and targeted injury prevention initiatives were designed and implemented. From the original proposal, many new and innovative interventions were added to improve musicians' health and respond to feedback and perceived needs from the musicians and their orchestral management personnel. These have included specific exercise programs, Alexander technique participation, on-site health advisory services a national hearing review, biomechanical performance assessment and embouchure assessment. Education programs have regularly been run on topics including music performance anxiety management, hearing conservation, injury prevention and management strategies. The results of these evaluations and interventions will provide the foundations for ongoing occupational health and safety guidelines to use best evidence to prevent injuries and effectively manage injured musicians in this industry. These guidelines will be the world first attempt to form a benchmark for this industry that will

have relevance both nationally and internationally. The report will be published in the final year of the project.

Summary of Trials Completed to Date

The project was awarded in October 2008 and funding commenced in August 2009 for 5 years. To date we have held 19 Education Sessions, and completed the following assessments and interventions:

Baseline Assessments:

- **Questionnaires**

Demographic information, BMI, fitness, practice habits, perceived exertion of playing, pain profiles (current and past), recovery from injury, psychological surveys - 378 players completed this survey. A hearing survey has also been completed to gather information on methods and strategies used to prevent noise-induced hearing loss.

- **Baseline Physical examination**

Baseline physical examination of volunteer participants to evaluate physical characteristics using available clinical tests from participating musicians – 407 players participated in this testing procedure. Results from this have been published as a series of normative data and provide some evidence of adaptive changes related to many years of instrumental performance. This study also revealed some limitations of standard evaluation techniques when working with elite performers who require extremely fine and rapid motor control rather than the more typical large-scale measures traditionally used in clinical practice.

- **Psychological Interviews**

Professor Kenny conducted in-depth interviews with a sub-group of musicians suffering from extreme music performance anxiety. This information led to a trial of a treatment program for these musicians being developed on the efficacy of short-term intensive psychotherapy on managing this condition.

- **Wind & Brass embouchure and breathing assessments**

Surface electromyography, a scientific method of measuring muscle activity, was used to evaluate the actions of the facial and breathing muscles during performance on a range of wind and brass instruments. Postures that the musicians played in were varied and 5 different excerpts were used to establish what effect this may have on the functioning of the facial and breathing muscular apparatus. Over 70 professional musicians participated in this project

- **Practice room noise exposure investigation**

An investigation of typical noise exposures faced by musicians when playing in purpose-designed practice rooms was conducted at the Queensland Symphony Orchestra. Dosimeters measured the noise produced by the instrument at the music stand as well as at the level of the musicians ears themselves. For some instruments, daily noise exposure limits were reached within an hour of practice of typical repertoire suggesting that improved hearing conservation strategies possibly including use of earplug during individual practice may be very important to prevent noise-induced hearing loss.

Interventions

i. Health Education Sessions

Regular sessions have been offered to the orchestras on all topics covered by the study to keep musicians informed on results and ways in which they can best act to protect their health at work. To date we have held 12 formal sessions. Participants are given updated information on the project, delivering results as they emerge as well as letting them know about upcoming trials. As well as this they are given advice and information in relation to maintaining good health and best ways to prevent and/or manage potential health issues related to physical, psychological or hearing concerns.

ii. Psychological Interventions

Expert clinical psychology practitioner, Steven Arthey, in consultation with Professor Kenny, conducted a series of intensive short-term psychotherapy interventions of between 8 and 12 sessions with eight musicians with debilitating music performance anxiety. The results indicated that for certain performers this approach was very effective, but that careful psychological screening was needed to identify participants most likely to benefit from this intervention.

iii. Exercise classes

Exercise classes were offered to all orchestras over a 10-week period and were designed to be able to be run in the lunch break to facilitate uptake. Overall, 78 participants completed attendance at over 80% of the classes. Results within 6 weeks of completion of the trial showed that participants reported a decrease of frequency and severity of playing-related pain symptoms. However, 6 months after the intervention had stopped these changes were no longer present, most likely reflecting the need for ongoing participation in musician-specific exercise programs.

iv. Exercise DVD trial

In response to feedback from the orchestra musicians that classes were difficult to attend for many players, an exercise DVD was created that contained the musician-specific exercises used in the trial. 146 musicians received a free copy of the DVD with accompanying exercise

equipment and instructions. A copy of this DVD will be made available to all orchestras for their libraries as a resource that can be borrowed by interested musicians.

v. Triage health advisory service:

Results from the baseline survey highlighted a high incidence of chronic physical conditions amongst the orchestral musicians (~25% of players), and feedback from the musicians indicated that they were sometimes unsure who to see when problems emerged. A team of physiotherapists with relevant post-graduate qualifications were trained in a method of providing advice to injured musicians, and these services were run fortnightly over a 3-month period. Of the 83 musicians who attended these services, 79% of these musicians rated the advice as helpful or very helpful, whilst 68% responded they were likely or very likely to continue to use the service in the future. The vast majority of injuries (83%) seen by these experienced physiotherapists were considered to be potentially preventable.

vi. Alexander technique lessons

Many music teachers are trained in a method of teaching postural and movement concepts incorporated into music lessons, known as the Alexander technique. Evidence for this method is not convincing to date, but it is very popular with musicians so it was decided to evaluate the perceived usefulness of this technique. The lessons were designed by Janet Davies, a Churchill Fellow, violin teacher and acknowledged expert in this field in close collaboration with Dr Ackermann and Associate Professor Tim Driscoll. Of the 49 musicians who participated in these lessons, no clear benefits were reported for reducing playing-related pain or injury, although players did report that they felt their posture and ease of movement had improved at both 6 weeks and 6 months following the completion of the classes.

Intervention Participation

Following table shows number of trials, volunteers and percentage of taking up of the trials within the orchestras.

Orchestra	No of individual trials	Volunteers for individual trials*	Average Uptake Per trial	FTE Orchestra Members	% of Uptake by Orch FTE
QSO	14	144	10.3	144 of 88	163%
MSO	12	99	8.3	99 of 93	106%
ASO	11	117	10.6	117 of 76	154%
TSO	9	82	9.1	82 of 46	178%
SSO	9	129	14.3	129 of 96	134%
WASO	8	102	12.8	102 of 76	134%
AOBO	8	115	14.4	115 of 69	167%
OV	6	81	13.5	81 of 70	115%
TOTAL	77	869	11.7	869 of 614	

*Excludes group sessions, baseline, wind & brass

Conferences, publications and meetings

The Project team have presented project results from the baseline measures and program interventions in 18 national and international health professional conferences.

The Project has published or submitted 13 publications to date, these have been sent to all orchestras for comment prior to publication. A copy of the published papers has been added as appendices to this document for your information.

The Project team has presented at 2 SOMA conferences, an orchestra liaison officer meeting, and coordinated and chaired 10 Liaison Officer Group Meetings and given 6 formal CEO Updates to the CEO Steering Committee.

Ongoing and Future Interventions

Continuing and planned intervention trials include:

- **Injury Surveillance System**

There have been two different attempts to refine an injury surveillance tool and a third version is being developed at the moment. The goal of this tool is to gather information in an ongoing way on exposures faced by musicians in terms of work demands and monitors any physical, psychological or other health issues that emerge over time. This information provides a more reliable method than recall to determine exposures faced by the musicians at work or elsewhere that may lead to health problems emerging. This allows identification of risk factors to health that can then be subsequently targeted and modified. In response feedback on issues encountered in a past on-line and paper attempt, the current tool in final stages of development is a web-based tool that has been developed in conjunction with an external expert. This tool has confidentiality as a priority but allows overall risks to be monitored and identified by orchestral management. In addition, musicians entering information can access personal data (only accessible to them), and this is hoped to enhance compliance with this tool. This has been very successfully used in the dance population. It is proposed that this may be a useful tool for orchestra management and musicians to use following the completion of the Sound Practice Project. This would achieve compliance with the following duty of care requirement of businesses under the new Workplace Health and Safety Guidelines (<http://www.safeworkaustralia.gov.au/sites/SWA/AboutSafeWorkAustralia/WhatWeDo/Publications/Documents/717/Guide-to-the-WHS-Act.pdf>)

“...that the health of workers and the conditions of the workplace are monitored to prevent injury or illness arising out of the conduct of the business or undertaking...”(p.7)

- **Performance Nutrition Study**

Nutrition is an important consideration in elite performance domains and has not been studied at all in musicians, despite the physical endurance requirements of their playing activities. The goal is to evaluate normal nutritional practices using a food frequency survey that has been developed by Dr Ackermann in conjunction with Sherel Levy, a dietician with interest and

expertise in this area. Once this has been analysed suggestions will be made on dietary needs for performance situations including pre-playing, during performance (in breaks) and to optimise recovery post playing.

- **Performance Psychology Pilot trial in Melbourne with MSO**

Many performers report being under-prepared with training in mental skills that may better enable them to face the psychological challenges of a performance career. We are aiming for a series of mental skills training workshops to be run at MSO in 2013 by Paulette Mifsud, a specialist clinical performance psychologist based in Melbourne. The ethics application for this is underway and will be sent to MSO management for review prior to submission.

- **Work Health & Safety Guideline/Site Visits**

We have approached each orchestra to meet with the WHS committees to discuss any other workplace factors that may influence health that may have not yet been covered by the research to date. In these visits we are also determining the extent of practicability of any recommendations made by the project team and how these may be refined for the current guidelines to fit within the orchestral workplace and meet the specific needs of musicians.

- **Active Hearing Device Trial**

This project involves an investigation amongst noise-exposed orchestral musicians into the usability of two styles of in-ear electronic hearing protection devices. One device is specifically designed for musicians apparently capable of delivering hi-fidelity sound to the ear at a safe level regardless of external noise levels. The other device uses externally mounted microphones and a belt-pack, enabling the user to choose the required level of attenuation and still delivering high fidelity sound to the ear. Thirty-two musicians selected from two professional orchestras will be fitted with the devices (twenty-four for one device and eight for the other) and be closely monitored over a period of four weeks during “at risk” programs for both their reaction to and their use of the devices, including during opera and ballet seasons. The devices will also be subjected to laboratory testing to determine if manufacturer’s claims of attenuation and fidelity are accurate.

- **Music Biomechanics Performance - Assessment and Feedback**

It is frequently reported that with the long hours of playing, even small inefficiencies in the way that players move whilst performing contributes to injuries developing or becoming more chronic. In this trial, musician volunteers have been videotaped individually during rehearsals to evaluate their playing movements from a clinical biomechanics perspective. The footage is edited into short film clips and shown to musicians in a one-on-one half hour feedback session to discuss findings. The feedback to date has been overwhelmingly positive and further work is

underway to develop a template to use for movement assessment of musicians to standardise assessment approaches.

- **Induction package**

In response to a request from the QSO WHS committee, the team is working on developing an induction booklet on WHS for orchestra musician employees. It is envisaged that this will be finalized by July 2013. This will help to satisfy the following criteria from page 7 of the Guide to WHS document:

“...the provision of information, instruction, training or supervision to workers needed for them to work without risks to their health and safety and that of others around them...”

Challenges

Participation in the trials of the Project have been well supported by the orchestra management, liaison officers and by the musicians overall. We are encountering some difficulties with continuing full participation, in part due to issues such as staff changeovers, attendance at voluntary calls, difficulties encountered in scheduling interventions or meetings, and availability of musician in relation to rostering. Some orchestras have been fully involved and participated in all the intervention trials and assessment programs; some have not participated as well. We have found that the orchestras with better participation have also been more enthusiastic about the project, and subsequently their attendance has been better at education sessions, assessments and research trials. When the Sound Practice project team visits the orchestras to undertake trials or deliver education sessions, it encourages greater participation. It is clear that when participation in health activities including educational activities or intervention trials (such as exercise programs) is facilitated for the musicians, the more actively engagement occurs.

Outcomes

The University of Sydney team has presented the results of this project nationally and internationally at health professional and music health related conferences, and this is leading to international endeavours to improve musicians' health. Publications have facilitated spreading the word regarding results, and all publications acknowledge the ongoing support of the Australian government and the orchestras in the Project. In addition, musicians have been encouraged to participate in this process and liaise with Dr Ackermann to develop manuscripts for the specific musicians journals or conferences.

We have received reports of improving health culture in the high participation orchestras.

The process of developing specific recommendations for orchestral WHS has begun and will continue as more data is gathered and analysed over 2013. The new WHS ACT will be used as a guide for recommendations. The final report will provide recommendations for prevention and injury

management for musicians and addressing occupational health and safety issues. The WHS induction handbook will be developed as an additional by-product of this study.

The Sound Practice Project is continue to produce research of both national and international significance and is attracting national and international recognition with invitations to speak at prestigious conferences already having been extended for next year. In addition, future collaborations with international partners are starting to occur to spread the knowledge and expertise gained as a result of this project.

It is hoped that ongoing work can continue with the Orchestras to build on the substantial base of work already completed and encourage healthy practice within the orchestral workplace.

Appendix 8 Publications arising from the Sound Practice Project

The attached publication list report on a multitude of findings from the Sound Practice project. Please contact Bronwen.Ackermann@sydney.edu.au for copies of any of these papers. Due to copyright restrictions, the papers cannot be attached to this document.

4. Ackermann, B.J., Kenny, D.T., O'Brien, I., Driscoll, T. (2014). Sound Practice—improving occupational health and safety for professional orchestral musicians in Australia. *Frontiers in Psychology*, 5: 973. Published online 2014 Sep 9. doi: [10.3389/fpsyg.2014.00973](https://doi.org/10.3389/fpsyg.2014.00973)
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4158789/>
5. Ackermann, B. J. & Driscoll, T.R. (2010). Development of a new instrument for measuring the musculoskeletal load and physical health of professional orchestral musicians. *Medical Problems of Performing Artists* (25), 95–101.
6. Ackermann, B.J., Driscoll, T.R., & Kenny, D.T. (2012). Musculoskeletal pain and injury in professional orchestral musicians in Australia. *Medical Problems of Performing Artists*, 27 (4), 181-187.
7. Ackermann, B., O'Dwyer, N., Halaki, M. (final draft preparation for submission) Facial muscle activity demands during performance in wind and brass musicians
8. Ackermann, B., O'Dwyer, N., Halaki, M. (2014). The difference between standing and sitting in three different seat inclinations on abdominal muscle activity and chest and abdominal expansion in woodwind and brass musicians. *Frontiers in Psychology*, (5), 1-9.
9. Chan, C., Driscoll, T., Ackermann, B. (2012). Development of a Specific Exercise Program for Professional Orchestral Musicians – A Methodological Study. *BMJ Injury Prevention* 19 (4), 257-263.
10. Chan, C., Driscoll, T., Ackermann, B. (2014). The Usefulness of On-Site Physical Therapy-Led Triage Services for Professional Orchestral Musicians - A National Cohort Study, *BMC Musculoskeletal Disorders*
11. Chan, C., Driscoll, T., Ackermann, B.J. (2014). Effect of a musicians' exercise intervention on performance related musculoskeletal disorders. *Medical Problems of Performing Artists*, 29 (4), 181-188.
12. Chan, C., Driscoll, T., Ackermann, B. (2014). Exercise DVD effect on musculoskeletal disorders in professional orchestral musicians. *Occupational Medicine*, 64 (1), 23-30.
13. Chan, C., Ackermann, B. (2014) Evidence informed physical therapy management of performance related musculoskeletal disorders in musicians. *Frontiers in Psychology*, 5, 706.
14. Chang, A., Kenny, D.T. & Burga, A. (2017, in press). Validation of the *Kenny Music Performance Anxiety Inventory* (K-MPAI): A cross-cultural confirmation of its factorial structure. *Psychology of Music*

15. Driscoll, T., Ackermann, B. (2012). Applied musculoskeletal assessment: Results from a standardized physical assessment in a national population of professional orchestral musicians. *Rheumatology* S2:005)
16. Driscoll, T., Ackermann, B.J., Galbraith, G. (2013). Surveillance of musculoskeletal disorders and risk factors in orchestral musicians. Published in: Williamon, A. & Goebel, W. (Eds). *Proceedings of the International Symposium on Performance Science*, Association Européenne des Conservatoires, Belgium 2013, pp: 171-174.
<http://www.performancescience.org/ISPS2013/Proceedings/>
17. Kenny D.T. (2011). *The Psychology of Music Performance Anxiety*. Oxford: Oxford University Press.
18. Kenny, D.T., & Ackermann, B. (2013). Performance related musculoskeletal pain and depression in professional orchestral musicians. *Psychology of Music*, published online 2 September, DOI:10.1177/0305735613493953
<http://pom.sagepub.com/content/early/2013/09/02/0305735613493953>
19. Kenny, D.T., Driscoll, T., & Ackermann, B. (2014). Psychological well-being in professional orchestral musicians in Australia: A descriptive population study. *Psychology of Music*, 42(2), 210-232.
20. Kenny, D.T. (Technical paper). Identifying cut-off scores for clinical purposes for the *Kenny Music Performance Anxiety Inventory* (K-MPAI) in a population of professional orchestral musicians in Australia. https://www.researchgate.net/profile/Dianna_Kenny
21. Kenny, D.T. (in review). Short-term psychodynamic psychotherapy for a severely performance anxious musician: A case report. *Psychotherapy*
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