ESC 102

REQUEST FOR PROPOSALS

Preventing Musculoskeletal Injuries (MSI) in Professional Musicians within Toronto

March 2, 2013

Abstract

This RFP addresses the prevalent problem of musculoskeletal injuries (MSI) within the performing musician's community.

"Musicians" are framed as musicians within the city of Toronto who rely on their ability to perform or play as the source of their primary income. These musicians practice on average 30-50+ hours per week [1] to maintain their musical skills. This workload significantly taxes the performer's body, and over time, these musicians are at increased risk for developing musculoskeletal injuries. In fact, up to 76% of all musicians [3] have had their career affected by a MSI. These musicians often also have no option to prevent overexerting themselves, as their financial safety lies in their ability to play.

Understanding that professional physiotherapy treatment is necessary beyond a certain point of severity (Further explained in section 2), this RFP requests for solutions that enable musicians to continue their practice routines whilst reducing the strain and inhibiting the injury from worsening. The primary stakeholder in this engineering problem is musicians, and secondary stakeholders include music teachers, music groups, and music stores (See section 4). A list of objectives and requirements has been derived from the needs of the primary and secondary stakeholders and consists of the DfX's of Ergonomics, Effectiveness, Affordability, Adaptability, and Simplicity (See section 5).

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1. Introduction

By learning to play an instrument, an individual gains skills that are extremely powerful outside the world of music, such as patience, hard work, and commitment. As such, many children are ushered to learn an instrument beginning at a very young age. Some of these children develop a profound admiration for music, and by the time they become young adults, decide to pursue a professional career in music. While there is nothing wrong with the aspirations of becoming a professional musician, it is an aspiration that requires a tremendous amount of practice, ranging from 30-50+ hours of practice per week [1].Even with perfect form and posture, professional musicians are still *very* susceptible to musculoskeletal injuries. However, professional musicians must continue to play to generate a sustainable income. One can easily see the problematic situation that these musicians face, as their injuries worsen over time, to the point where it affects many aspects of their lives beyond music [2].

2. Background

2.1 Professional Musician Community

The community identified consists of musicians within the city of Toronto, who rely on their playing as the source of primary income (income directly related to participation of households in the production process as per defined by National Institute of Statistics and Economic Studies [3]). The community is referenced within this document as professional musicians. Professional musicians place the greatest value in their music. [1], As such, they often ignore the side effects of prolonged playing. "A musician does not focus on pain but on the music." [4]This single minded focus often leads to sever injuries on the body and mind, and one of the most common is muscleskeletal related injuries. [5]

2.2 Musculoskeletal Injuries in Musicians (MSI)

Professional musicians exhibit a high frequency of occupational injuries; a large study of North American professional orchestral musicians (ICSOM) reported that 76% of players had experienced injuries that affected their performance [3]. One can easily see the gravity of this problem. However, not everyone in the 76% suffering MSI experience the same level of discomfort. This is because MSIs are developed and worsened over time, as one might expect. [2]

2.2.1 What is a Musculoskeletal Injury?

A Musculoskeletal injury is defined to be “any injury or disorder of the muscles, bones, joints, tendons, ligaments, nerves, blood vessels, or related soft tissues. This includes strain, sprain, or inflammation that is caused or aggravated by activity.” [2]

Professional musicians spend a significant amount of time on practice (30 -50+ hours per week [1]), rehearsal or performance. The physical and professional demand creates significant stress on the body and results in musculoskeletal related injuries. [2] Common MSIs that musicians experience are [2]:

- Tendon inflammation
- Muscle cramping
- Muscle strain
- Compression or entrapment of nerves that affect the hands, arms, neck, back, or face

Some well-known MSI in musicians include carpal tunnel, focal dystonia, epicondylitis, tendinitis or tenosynovitis, and lower back pain [6]. For detailed list please see appendix C.

2.2.2 Musculoskeletal injury Risk Factors for Professional Musicians

As per publication by The National Institute for Occupational Safety and Health (NIOSH), risk factors for MSI include environmental aspects, physical properties and personal characteristics [7]. The following chart outlines key risk factors in regards to professional musicians based NIOSH publications.

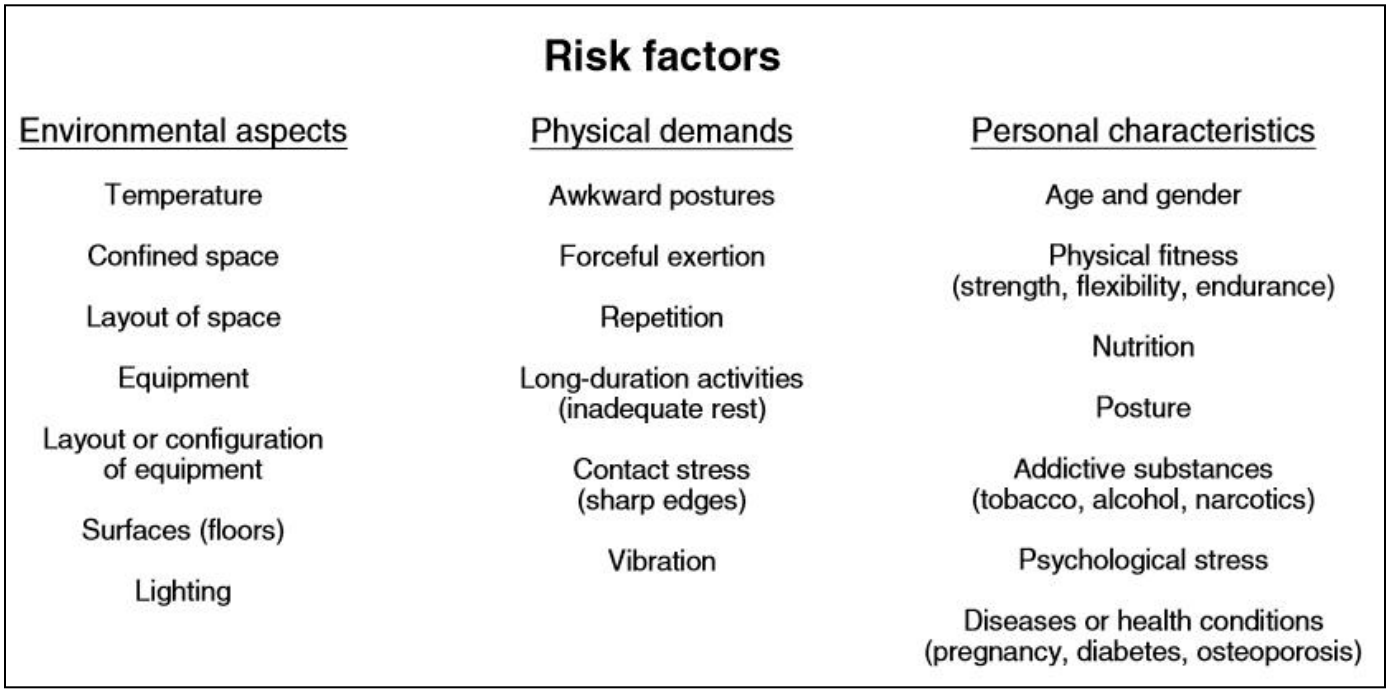

Figure 1: Risk Factors for MSI [2] [7]

In most cases, an extreme single risk factor or the occurrence multiple risk factors are more likely to trigger MSI. [7] For most professional musicians, the greatest risk of MSI is associated with situations that involve [2]:

- Improper use of technique
- Intense preparation for performance
- Preparation of a new and difficult piece
- Prolonged performance without adequate rest

2.2.3 Health effects of MSI

MSI early signs and symptoms [2]:

- Pain
- Weakness
- Numbness
- Tingling Sensations
- Stiffness (reduced range of motion)
- Loss of muscular control

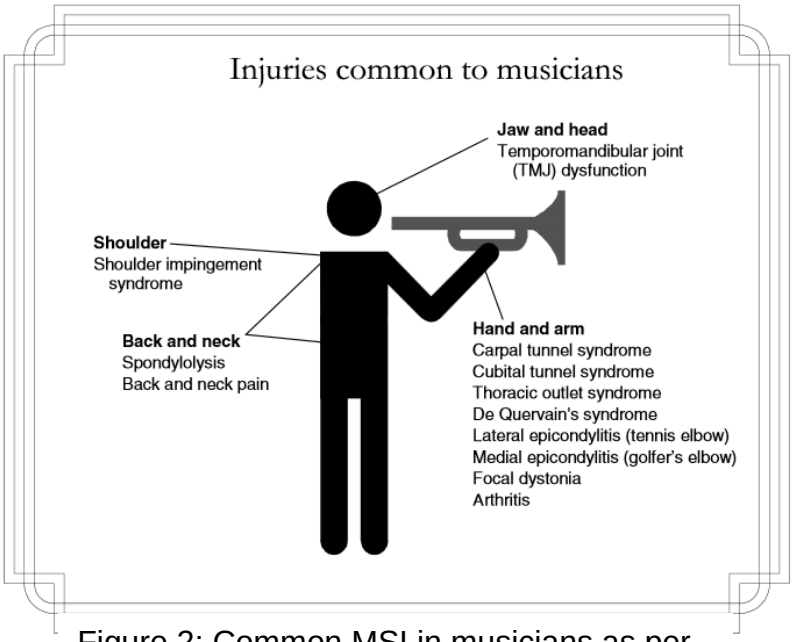

Figure 2: Common MSI in musicians as per Safety & Health in Arts and Production [2]

MSI- related Health effects [2]:

- Strains
- Sprains
- Disc herniation
- Tendinitis
- Tenosynovitis
- Bursitis
- Nerve compression
- Nerve degeneration
- Bone degeneration or malformation

While a MSI is neither life threatening nor medically serious (as viewed by the medical/health community), it has the capability of significantly limiting, or perhaps even terminating careers. [2]

2.2.4 Levels of MSI

Health professionals classify the severity of signs and symptoms using a graded scale that represents the progression of a typical overuse injury. This scale, adapted for performers, is illustrated in Table 1.

Level 1	Pain occurs *after* class, practice, rehearsal, or performance, but the musician *performs normally*
Level 2	Pain occurs *during* class, practice, rehearsal or performance, but the musician is *not restricted* in performing
Level 3	Pain occurs *during* class, practice rehearsal or performance, and begins to affect some aspects of daily life. Musician begins altering techniques, and shortens duration of practice.
Level 4	Pain occurs as soon as the musician participates in class, practice, rehearsal, or performance, and is too severe to continue. Many aspects of daily life are also affected
Level 5	Pain is continuous during all activities of daily life. The musician is unable to participate in class, practice rehearsal, or perform.

Table 1: Levels of MSI Severity in context of musicians [6]

3. Engineering Problem Statement

3.1 Identifying the need

At the professional level, Musicians often experience pain as a consequence of prolonged repetitive work early in their career. Such pain is compounded by the lack of breaks during concerts and rehearsals. Ignoring pain and potential damage is an accepted concomitant to striving for perfection**.** [4]

As well, professional musicians utilize their performances to generate a significant portion of their income (ranging from $22,500 to 67,000 per year [8], depending on the level and type of performance). However, continuous practice followed by performance after performance taxes the musician's physical well-being. Yet the musicians cannot stop, as doing so would mean a significant blow to his/her financial situation. As such, the musicians are often force by circumstance to continue to practice and perform while the pain they experience slowly and steadily worsens.

To quote Dr. John Chong, (Founder/Operator of Musicians Clinic of Canada) [9], while there is substantial research and progress made in sports injury rehabilitation, the field of musician injury rehabilitation is severely underdeveloped despite the fact that the two fields are functionally identical.

Therefore it is apparent that the professional musician community needs assistance in prevention of MSI injuries.

3.2 Purpose of the solution

It is important to recognize that beyond level 3 MSI (as defined in 2.5), professional assistance is required, and is thus no longer within the scope of this RFP. Accordingly, the high level objectives of the solution are:

1. Prevent worsening of MSI for musicians showing early symptoms and/or in early stages.
2. Actively assist the recovery process of Musicians currently experiencing early stage MSI.
3. Accomplish #1 and #2 in such a way that does not significantly hinder the musicians' ability to practice/perform

4. Stakeholders

The following (Figure 3) provides an overview of stakeholders who may have influence on the risk of MSIs as per defined by industry [2], Detailed exploration of key stakeholders are listed as subsections below.

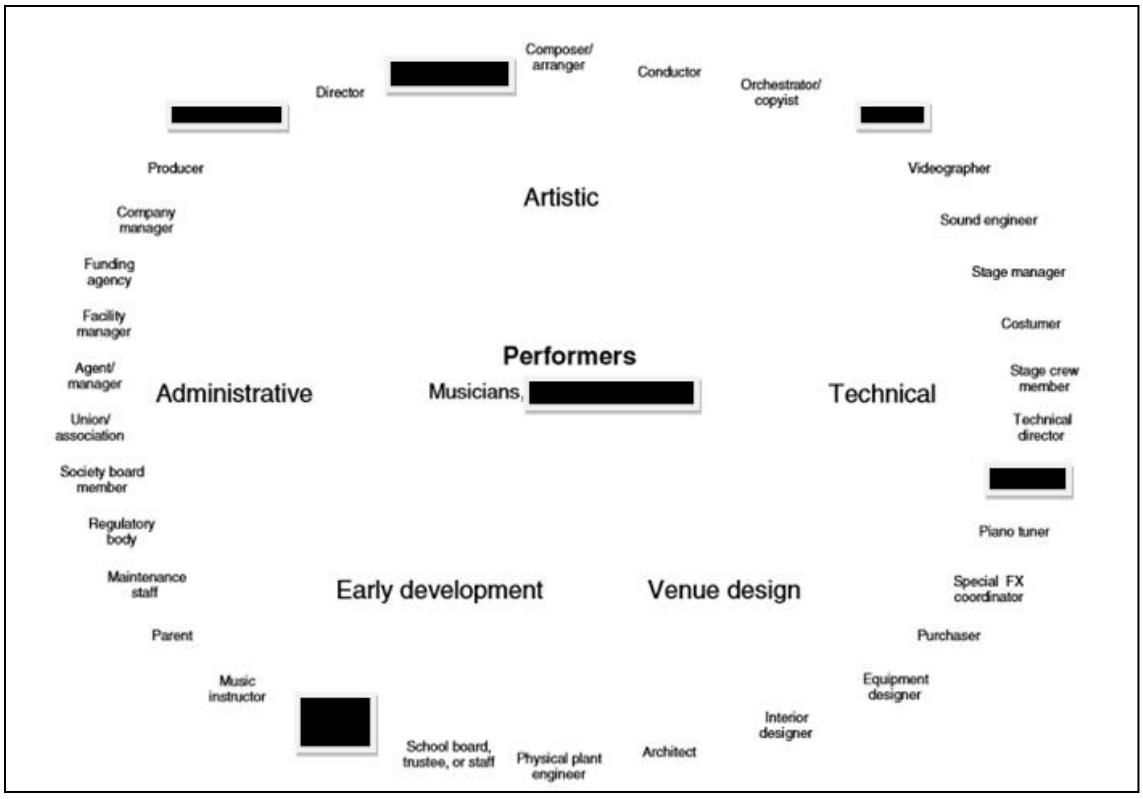

Figure 3: Stakeholders overview as per defined by the industry in Arts Production and Entertainment, the overview is for musicians, vocalist and dancers, thus some stake holders are covered. [2]

4.1 Musicians

Musicians are, unsurprisingly, the primary stakeholder in this RFP. They are effectively the “client” and the ones who will ultimately benefit from the solution of this project. As such, it is important to take into consideration the reasons some of these individuals developed MSI in the first place (section 2), and secondly apply this knowledge to develop a solution that musicians will choose to incorporate into their practices.

4.2 Musical Stores

Music stores are undoubtedly the go-to place for anything and everything related to music. When musicians are in need of accessories for their instrument (i.e. shoulder rest for violins, saxophone neck straps, etc), the first place they will look is the musical store. [1] As musicians of all kinds will frequently visit these stores, the stores serve as ideal locations for the distribution of the solution (granted it is a solution that can be distributed) as the marketed solution will receive much more exposure to musicians.

4.3 Music Teachers

Teachers have a significant power of influence [10] on their students, and music teachers are no exception. Music teachers can significantly impact their student’s views and opinions on numerous matters regarding the industry. This impact translates into the ability to influence a student’s sense of “right” and “wrong.” Specifically, music teachers’ decision to promote or discredit the solution will be a tremendous benefit or detriment to the solution’s popularity in the seeable future. Furthermore, many music teachers (at a higher level) are very traditional. This mentality derives from the inherited nature of a student’s teaching method (typically inherited from the students’ teacher). As such, music teachers hold a significant stake in this problem, as solutions that impede a teacher’s traditional beliefs may be frowned upon by not only the teacher, but his/her students as well.

4.4 Music Organizations

Some performers may be subjected to groups (such as an orchestra), and as such must uphold standards and requirements as defined by the group [11]. Accordingly so, the organizations hold a stake in the consideration of this problem, as some upcoming musicians join orchestras and concert bands as a way to enter the industry. If the proposed solution is not in line with the requirements of the orchestra, it is very likely that the solution will be overlooked by many musicians.

5. Requirements

5.1 Objectives

The objectives should reflect the design goals of the solution.

1. To slow the progression of MSI in musicians sufficiently that they can practice their instruments. This solution should
    a. Allow the musician to practice his/her instrument without damaging the injured part of his/her body
    b. Allow the musician to practice his/her instrument without a significant decrease in his/her range of motion
2. To create an affordable and adaptable solution to different types of MSI, this solution should:
    a. Be an affordable solution
    b. Be applicable to more than one instrument class
3. To create an intuitively simple solution, this solution should be:
    a. Intuitively easy to learn how to use and to enact.

5.2 Criteria

The solution shall be critiqued by the stated criteria. These criteria are listed in the order of decreasing importance.

- **Effectiveness**
    - The extent to which the solution decreases the amount of strain placed on the body of the musician at the point of injury when the musician is practicing his/her instrument. (metric:[less strain is better])
- **Ergonomics**
    - The range of motion that the musician can achieve during practice when the solution is implemented.(metric:[larger range of motion is better])
- **Affordability**
    - The extent to how financially feasible the solution is to the target audience: musicians. (metric:[less cost is better])
- **Adaptability**
    - The range of instrument classes and different MSIs which the solution is applicable to. (metric:[more instrument classes applicable is better])
- **Simplicity**
    - The amount of time taken for a user of the solution to learn how to use and then implement the solution properly. (metric:[less time taken to learn and use, the better])

5.3 Constraints

The solution shall be bounded by these constraints as they are judged to be pivotal basic requirements. Justification must be given if any of these constraints are ignored and violated.

- The solution must be operationally safe, not inflicting any damage on the user.
- The solution must effect a measurable decrease in the strain on the musician's body
- The solution must not decrease the musician's range of motion in such way that it is unfeasible for the musician to practice
- The solution must be adaptable in such way that it applies to at least more than one instrument class (ex: clarinet, trumpet, violin)
- The solution must be designed such that the cost must not exceed $25 per use, half of the cost of a 20 min physiotherapy session. [12]
- The amount of time for an individual to spend to learn how to use the solution must not exceed 20 minutes
- The amount of time needed to implement the solution must not exceed 10 minutes per time playing instrument.

5.4 Table Summarizing 5.1-5.3

Objective	Criteria	Constraint	Metric
Effectiveness	Strain placed on the musician's point of injury during practice/performance	Must reduce the strain on the musician's body	Amount of strain on the musicians' body at the point of injury. The less, the better. (Measured through electromyography, EMG)
Ergonomics	Effect on the musicians' range of motion	Must not reduce range of motion such that practicing instrument is not feasible	Percentage of motion possible in comparison to normal musician (higher is better)
Adaptability	Applicability to the number of instruments	Must at least be applicable to more than just 1 instrument class	Number of instruments applicable (higher is better).
Affordability	Cost of the solution	Cost must be less than $25 CAD per use [11]	Cost in Canadian dollars (lower is better)
Simplicity	The ease of which a musician can use the solution	The time taken to learn how to use the solution and the needed to use the solution must be less than 10 minutes per use.	Time (in min) needed to learn how to use the solution and the time needed to use the solution once learnt (lower is better)

6. Reference Solutions

There are limited solutions present to the issue of MSI prevention for musicians, thus driving the need for a more comprehensive approach. Most of the current solutions are confined to pre-playing warming up exercises, small accessories or adjustments to the instrument and physiotherapy exercises, as a way to prevent MSI.

6.1 Pre-Playing Warm Up

Warm up exercises can prepare the muscles and increase the flexibility for the musician [13]. Regular stretching exercises maintain flexibility of the joints and keep the muscles working smoothly. Stretching allows you to let go of tension. The muscles in the back, neck, buttocks and backs of the legs tend to be cramped from daily activities which can be reduced by stretching [14].So, stretching can increase sensitivity to sounds and sensations, in addition to improving the ability to move the fingers, hands, joints, and muscles. [13] [14]

While warming up exercises can apply to multiple instruments, it is time consuming, as well as having limited scientific proof of effectiveness (multiple studies with conflicting results) [14].

6.2 Small Accessories / Instrument Modifications

Accessories and instrument modifications can effectively relive some issues related to MSI by modifying the playing position [6]. However, they are most often specialized to a single instrument such as high chin-rests for violins, shoulder straps for saxophones and modified flutes (see figure 4).

Figure 4: Modified flute (left) [6] and saxophone shoulder strap (right) [6]

6.3 Strengthening Exercises

As the name suggests, these types of exercises' main purpose is to strengthen the muscles related to the playing of instruments, by doing so reduce the risk of injury. While these exercises can be beneficial, it is time consuming and requires professional aid. The examples of such exercises are shown below.

6.3.1Trigenic Myoneural Medicine (TMM)

Trigenics Myoneural Medicine is a physiotherapy treatment that focuses on the restoration of the damaged nerve connections caused by MSI [15]. Trigenics addresses the phenomenon that injured muscle groups not only suffer a decrease in muscle strength, but the neural connections suffer as well [15]. Trigenics focuses on short term repairs on the neural connections by stimulating the injured muscle groups. This causes the injured muscle groups to communicate with the brain, strengthening the neural connection as a result [16]. This versatile and simple procedure produces considerable improvements in mobility and strength at injured muscle locations in the matter of minutes. However, this increase in strength and mobility is only temporary and therefore is suitable for use right before an MSI afflicted musician practices [15].

6.3.2 Physiotherapy Exercises

Physiotherapists work with patients helps them recuperate from disabilities and injuries. They can provide detailed and professional diagnoses of MSI cases, and direct patients to receive traditional treatments such as splints, mechanical aids, retraining techniques, and even surgery if necessary [17]. Physiotherapists will consistently give excellent treatment of MSI in musicians [17], but appointments are expensive and current traditional treatments either prohibit the musician from practicing while injured or does not adequately address a musician’s unique needs.

Work Referenced

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Appendix A

Interview excerpts with Michael Huang (professional musician and music teacher) [1]:

Q: How often do professional musicians practice?
A: 30-50+ Hours per week, depending on the number of performances he/she has, travel time, etc.

Q: When practicing in those amounts, do you suspect that these musicians will still develop health problems such as carpal tunnels, etc.?
A: With the proper posture and form, I think the chances of carpal tunnels and those type of injuries decrease significantly; one of the famous Chinese pianists I know of is known to do common exercises and stretches, etc. However, I don't think that I have enough experience in the muscles, kinesiology, and/or physiotherapy to properly answer this question.

Q: From our preliminary research, we found that roughly 50% of musicians develop some form of MSI. For a task posed to first year engineering design class, do you think that it would be better to prevent the development of MSI, or to assist the rehabilitation process?
A: I think you should focus on rehabilitating, because promoting proper posture and form, which all help reduce the likeliness of MSI are more on the teacher's responsibilities.

Q: There is also some claims that we have found that say musicians tend to practice through the pain, or to ignore pain they experience. What do you think about this statement?
A: It's pretty accurate. I have a few colleagues and friends who practiced insane amounts in preparation for performances and recitals. Most of them do it because they love to perform, and some others also have a "the show must go on" idea.

Q: Do you think that sometimes music teachers, yourself included, can be a bit traditional in your methods? For example, do you teach your students the same way your teacher taught you? And/or do you share the same opinions on certain matters as your teacher, as a direct result of having been their student?
A: I think this is really true, since I really do experience this first hand. For example, my teacher said that electric pianos are bad, and that they will never be as good as a real piano. Since then, I had made it a rule to never buy one, and I even told my parents, and I still tell my students this. Even though now, I completely understand the benefits and trade-offs of electric pianos (they are cheap alternatives), I still have a strong bias against electric pianos.

Q: How often do you visit a music store?
A: Not very frequently, but that's also because I don't have much I need to purchase anymore. Over the years, I've collected a large enough collection of scores for my teaching, and I can find new scores online. Other instruments though, and students, should visit at least once or twice a month.

Appendix B

Interview with Dr. J. Chong (founder and director of Musicians' Clinic of Canada) and C. Lombardo sales representative of Noraxon (a biomedical company).

Q: Are there any types of MSI that are particularly prevalent among classical musicians?
A: Due to the fact that there are many different types of classical instruments, each instrument class have their own unique problems. And in each instrument class, there is a large range of different injuries that could happen. So no, there is no “one” type of MSI that is especially prevalent.

Q: So how do you and your group measure the strain on each muscle group? How does that happen?
A: We use EMG biofeedback, equipment provided by Noraxon, to detect the signals sent to the muscles of the body by the neurons. Essentially the more signals detected at a muscle, the harder the muscle is working. This strain on the muscle therefore increases the chances of injury significantly.

Q: So this EMG technology measures muscle signals, does this also account for strain on tendons and bone as well?
A: Yes, if say a joint is moving in a way that it shouldn’t, it would also reflect in the muscle signals. This is why EMG biofeedback is especially elegant, it essentially simplifies injury diagnosis to reading electrical signals. Noraxon’s Myomotion sensors are particularly interesting because they are compatible with EMG interfaces and they are incredibly sensitive motion sensors that can measure the 3-D motion of your skeletal structure.

Q: So how expensive is this Myomotion system?
A: It’s fairly inexpensive for something of this scale. Depending on the configuration, it costs about $50,000.

Q: So, just wondering, why are there so many injured musicians who keep on playing?
A: The sad thing is that these musicians are afraid of disclosing their injuries. If they reported their injuries to the group they play in, they might get replaced by a healthy player. They also lose an important source of income when they take a break from playing to heal. So they are afraid, and rightly so, of losing their jobs if they report their injuries.
Q: How does PAMA plan to solve this? Is there a solution?
A: We’re currently trying to raise awareness of this problem across universities and large music groups. We’re trying to teach young musicians in music schools that it’s ok to disclose injuries.

Appendix C

Chart taken from [2].

Musculoskeletal injuries associated with specific instruments

Violin/viola	**Guitar**
Neck pain	Triceps tendinitis (right)
Thoracic outlet syndrome (left)	Focal dystonia of index and middle fingers and thumb (right)
Carpal tunnel syndrome (left)	Thoracic outlet syndrome (left)
Cubital tunnel syndrome (left)	Carpal tunnel syndrome (left)
Flexor carpi ulnaris tendinitis (left)	Flexor carpi ulnaris tendinitis (left)
Rotator cuff tendinitis (right)	Strain of dorsal interosseous (left)
Extensor carpi radialis tendinitis (right)	
Temporomandibular joint dysfunction	
Cello/string bass	**Harp**
Neck pain	Neck pain
Ulnar nerve entrapment (left)	Flexor and extensor tenosynovitis of thumbs
Flexor carpi ulnaris tendinitis (left)	Extensor carpi radialis tendinitis (left)
Rotator cuff tendinitis (right)	Medial epicondylitis (left)
Extensor carpi radialis tendinitis (right)	Flexor hallucis longus tenosynovitis of big toe (right)
Vocals	**Saxophone**
Vocal cord strain	Back and neck pain
Facial and neck muscle strain	Extensor carpi radialis tendinitis (right and left)
Focal dystonia of vocal cord muscles	Temporomandibular joint dysfunction
Clarinet	**Bassoon**
Carpometacarpal joint strain (right)	Back and neck pain
Carpal tunnel syndrome	Temporomandibular joint dysfunction
De Quervain's syndrome (right)	Dental problems
Lateral epicondylitis (right and left)	Strain of teres major and pectoralis major (right)
Temporomandibular joint dysfunction	De Quervain's syndrome
Oboe	**Flute**
Extensor carpi radialis tendinitis (right)	Thoracic outlet syndrome (left and right)
Lateral epicondylitis (right)	Ulnar nerve entrapment (left)
Ulnar nerve entrapment (right)	Extensor carpi radialis tendinitis (left)
Posterior interosseous nerve entrapment (right)	Back and neck pain
Back and neck pain	De Quervain's syndrome (left and right)
De Quervain's syndrome	Focal dystonia of ring and little fingers (left)
Trombone	**Trumpet**
Focal dystonia of lip	Maxillofacial and lip trauma
Lateral epicondylitis (right)	Pharyngeal dilatation
Strain of orbicularis oris	
French horn	**Bagpipes**
Temporomandibular joint dysfunction	Focal dystonia of ring and middle fingers (right)
Strain of extensor carpi radialis (right)	
Strain of dorsal wrist ligament (right)	**Tuba**
Strain of orbicularis oris	Strain of orbicularis oris
Percussion	**Keyboards (piano/organ/accordion)**
Lateral and medial epicondylitis	Thoracic outlet syndrome
Flexor carpi ulnaris tendinitis	Medial and lateral epicondylitis
Extensor carpi radialis tendinitis	Tendinitis of wrist flexors and extensors
De Quervain's syndrome	Carpal tunnel syndrome
Carpal tunnel syndrome	De Quervain's syndrome
Achilles tendinitis	Dorsal wrist ganglion
	Focal dystonia of thumb, finger, hand, and foot muscles

Note: This table is based on reports by Chong et al. (1989), Fry (1986a and 1986b), and Norris (1993). This is not an exhaustive list of all MSIs or instruments. If you are aware of any other common MSIs, please contact SHAPE (see page 1 for contact information).