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Musicians and Performance Related Injuries to the Hand

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University of North Dakota

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MUSICIANS AND PERFORMANCE RELATED INJURIES
TO THE HAND

by

Leona Pang
Bachelor of Science in Physical Therapy
University of North Dakota, 1995

An Independent Study
Submitted to the Graduate Faculty of the
Department of Physical Therapy
School of Medicine
University of North Dakota
in partial fulfillment of the requirements
for the degree of
Master of Physical Therapy

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1996
This Independent Study, submitted by Leona Pang in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Faculty Preceptor)

(Graduate School Advisor)

(Chairperson, Physical Therapy)
PERMISSION

Title Musicians and Performance Related Injuries to the Hand

Department Physical Therapy

Degree Master of Physical Therapy

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ABSTRACT

Musicians spend a great amount of energy and time preparing for auditions, competitions, performances, and recitals. The process of developing techniques and learning musical pieces requires practice sessions filled with long hours of repeating musical passages and awkward upper extremity positions. Performance related injuries often result from these conditions. Injuries include joint disorders, musculotendinous disorders, muscle cramps and pain disorders, neurological disorders, and focal dystonia or occupational palsy disorders. Pain, numbness, tingling, muscle cramping, and motor dysfunctions are associated symptoms. If symptoms are ignored and intense performance is continued, the musician can experience tissue damage and permanent loss of function.

Research has indicated that the hand, the wrist, and the fingers are the areas of the body where performance related injuries are most frequent. This literature review will focus on the common hand injuries experienced by musicians. Common types of injuries, evaluation procedures, treatments, and prevention techniques specific to the needs of musicians will be discussed.
CHAPTER I
INTRODUCTION

Performance related injuries of musicians have been called overuse syndromes,\textsuperscript{1-6} repetitive strain injuries,\textsuperscript{6} cumulative trauma disorders,\textsuperscript{7} misuse syndromes,\textsuperscript{8} and performance induced injuries.\textsuperscript{9} Overuse syndromes involve overtaxing physical structures when performing tasks of long durations.\textsuperscript{7} Repetitive strain injuries are compromised physical structures due to repeated movements.\textsuperscript{6(pp375,376)} Microscopic tears of physical structures are often involved. Cumulative trauma disorders are musculoskeletal and neurological disorders resulting from intense force and highly repetitive tasks.\textsuperscript{9(p411)} Continuing these tasks after experiencing the initial symptoms of pain further traumatizes the existing injuries. Misuse disorders result from incorrect technique, improper extremity positioning, poor posture, and poor body mechanics when performing tasks for a lengthy period.\textsuperscript{3(p38),4}

Musicians are particularly susceptible to performance induced injuries involving multiple intrinsic and extrinsic factors. Intrinsic factors are individual to the musician and include the individual's playing method, physical condition, and psychological and emotional mind frame.\textsuperscript{6(p371)} Extrinsic factors include the technique utilized; the performance environment, including ergonomic issues and body mechanics; any music technique or repertoire changes which are often due
to teacher changes; and the practice session duration. Symptoms of performance induced injuries may occur during or after performance.

Treatment philosophies for performance related injuries are split between two main existing viewpoints. Many of today's clinicians and music teachers specializing in performing arts medicine support one or the other viewpoint. The first viewpoint is that lengthy instrument playing is a primary factor contributing to performance related injury. Australian clinician, Hunter Fry, believes that some musicians are genetically predisposed to injury with lengthy repetitive activity. Each musician's physical limitations will be based upon his or her strength and physical makeup. He supports the previously mentioned extrinsic and intrinsic factors as contributors to injuries.

The other viewpoint of performance related injury is that musicians develop misuse syndromes from improper technique. Several British clinicians and members involved in occupational hazards promote this belief. They believe that the term misuse describes performance related injuries better than "overuse." "Overuse syndrome" implies that lengthy periods of musical playing are the primary cause of injuries. However, based upon studies surveying the prevalence of musicians with performance related medical problems, it was noted that many musicians with no performance related problems practice five or more hours a day. Therefore, misuse should be viewed as the primary cause of performance related injury.
Parallels of the Musician and the Athlete

The level of involvement of the professional musician in music is similar to the professional athlete in sports. Musicians and athletes train intensely for competitions or performances. Musicians audition for positions in groups similar to athletes trying out for a team. Professional soloists are similar to individual sports athletes. Both enter competitions with the intent on winning. Both athletes and musicians require skills of coordination, speed, high concentration, physical endurance, and agility. Practices for both involve physical conditioning with repetitive activities to refine techniques and skills. Their psychological needs are also similar. Both must manage their performance anxieties and stress levels before and during performances. They also are aware of their bodies' abilities and of any changes that affect their ability. Severe injuries would jeopardize the careers of both the athlete and the musician.

Performance related injuries of musicians and athletes are a subcategory of occupational medicine. Both musicians and athletes can develop overuse injuries in the upper extremities similar to workers. Although musicians, athletes, and workers perform different tasks, their activities involve long periods of repetitive motions. In addition to repetitive motions, activities of musicians and workers often require holding the upper extremities in static positions for long periods of time. Some of these positions are awkward and unnatural to normal body mechanics. Like the worker, prevention techniques and ergonomic adjustments help preserve functional abilities. The similar association between
athletes and musicians have led clinicians to model the evaluation and treatment programs for musicians after that of athletes and workers.\textsuperscript{12}

History of Performing Arts Medicine\textsuperscript{18}

The earliest records identifying musical performance as a source of medical problems were found in Europe. In the early 16th century, an Italian physician named Bernardino Ramazzini compiled a list of pathologies that he believed were associated with excessive instrument playing. These conditions were recorded in his book called "Disease of Tradesman." At the turn of the 19th century, multiple researchers and music teachers began studying and developing technical skills specific to each instrument. In the 1800s, multiple physicians studied the prevalence of occupational cramps in musicians. By the 20th century, music and medicine began to merge.

Early 20th century physicians followed their predecessors by categorizing and compiling music related injuries of every part of the body. Dentists began to be involved with music related injuries involving the mouth, face, and teeth. Dermatologists were involved with studies dealing with skin allergies involving instruments and their required preservatives. Psychiatrists and counselors became involved with performance anxiety issues and personal emotional issues of performers. Since musculotendinous injuries were common, physical therapists also became involved with the evaluation and treatment issues of performing arts medicine.

In 1981, several medical facilities offered performing artists medical services. By 1989, over 20 facilities had developed programs to treat musicians
and their medical problems. These clinics were satellite hospital clinics, private practices affiliated with university based hospitals, and private outpatient services. Professionals involved in performing arts medicine included internists, orthopedists, neurologists, otolaryngologists, physiatrists, psychiatrists, psychologists, physical therapists, occupational therapists, speech therapists, speech pathologists, hand therapists, voice therapists, social workers, chiropractors, acupuncturists, nutritionists, industrial hygienists, music teachers, and practitioners of Yoga, the Alexander method, and the Feldenkrais method.

In addition to the development of performing arts medical clinics, music and medicine joined efforts in combining conferences and a journal. In 1983, Alice Brandfonbrener and Richard Lederman organized the first Medical Problems of Musicians Conference which was held at the Aspen music festival. This conference invited all professions involved in Performing Arts Medicine to present issues pertaining to the field. In 1986, medical clinicians, professional musicians, and music teachers collaborated and organized the quarterly journal, The Medical Problems of Performing Artists. This journal presents articles about concerns, treatment issues, research studies, case studies, and prevention topics pertaining to musicians their injuries. Presently, numerous international organizations and conferences have developed an interest in performing arts medicine. The American Physical Therapy Association is beginning to present information about Performing Arts Rehabilitation through the Orthopedic Section's special interest group. Physical therapists have focused their
6
treatment approach for musical injuries by integrating sports medicine and occupational medicine strategies.\textsuperscript{14,22}

Etiological Factors of the Injured Musician

Etiological factors of performance related injuries of musicians have been identified through research. Thirty-five to 45 years of age is the age range with the highest prevalence of injuries. Due to hormonal changes, adolescent females also have a high incident of injuries.\textsuperscript{15} Musculotendinous injuries in the hand and forearm are the most common type of injury. Pain has been the most frequent symptom reported.\textsuperscript{16} The instruments associated with the greatest number of overuse hand injuries are the piano, violin, viola, cello, guitar, clarinet, oboe, and English horn.\textsuperscript{18} Instruments with the least association with hand injuries are percussion and brass instruments.

These etiological factors are based on studies utilizing surveys and case studies. However, many musicians with injuries do not want to participate in studies. Research to find associated causes of injuries has also resulted in variable results.

The Hand

The hand is one of the most commonly injured areas of the body. The anatomy, physiology, and function of the hand must be recognized before the incidence of hand disorders can be understood.

The hand is the most distal part of the upper extremity.\textsuperscript{20} It has the most contact with objects during functional activities. The amount of mobility in the shoulder will indirectly affect the hand's reaching ability. The hand and the
shoulder function together. All nerves and blood vessels branching into the hand must pass through the shoulder, the elbow, and the wrist. Nerves and vessels are also imbedded between other structures such as muscles, tendons, ligaments, and bones. Muscles controlling wrist and finger movements originate outside of the hand. Muscles within the hand produce abduction, adduction, opposition movements of the fingers, and arching of the palm. Compromise of any of the mentioned structures in the upper extremity can lead to multiple symptoms experienced in the hand.

Purpose of this Literature Review

Because most performance related injuries are musculotendinous in nature, physical therapists will be involved in the evaluation and the treatment of musicians. Understanding the musician's medical and performance needs and effectively addressing evaluation, treatment, and compliance issues will contribute to success in reaching the full rehabilitation potential of the musician. This literature review will present an overview of performance related hand injuries and information on the evaluation, treatment, and prevention of hand injuries specific to musicians. This information will assist the entry level physical therapist in the general evaluation and treatment of musicians with hand injuries resulting from musical performance.
CHAPTER II
PERFORMANCE RELATED INJURIES OF THE HAND

Musicians with performance related injuries have the same basic classifications of overuse disorders associated with athletes and workers.\textsuperscript{10,24(p7)} Calabrese and R. Lederman\textsuperscript{17} identify five categories of overuse injuries: 1) bone, joint, and bursa inflammation disorders, 2) musculotendinous disorders, 3) muscular cramp and pain disorders, 4) nerve entrapment and sensory disorders, and 5) occupational palsy or focal dystonia. Each of these categories will be discussed relative to pathophysiology, etiology, and associated symptoms. Musicians who commonly experience these injuries will be identified.

Bone, Joint, and Bursa Disorders

Basically, bone and bursa disorders are not commonly associated with performance induced injuries.\textsuperscript{23} These injuries are more common to trauma which will not be discussed in this paper. However, musicians do encounter joint problems. Joint disorders involve joint laxity or hyperextensibility, ligament damage, and osteoarthritis.

Performance may contribute to joint laxity.\textsuperscript{3,23,24} Excessive force absorbed by the fingers or hand from striking a rigid surface or vibrating string can result with increased joint mobility. Connective tissue and ligaments may be stressed to the point whereby they cannot return to their original lengths. This results in
ligament laxity which decreases the stability of attached joints. One clinic found that 20% of their patients with overuse pain conditions also had joint hypermobility of over 10° of the normal range of motion. Increased joint laxity occurs frequently with pianists, string instrumentalists, and guitarists.

Some people have more than average joint flexibility due to genetics. This condition of joint hypermobility is known as benign joint laxity. Some clinicians believe that benign laxity can benefit musicians by enabling them to perform difficult techniques requiring stretching of the hand such as chords or octaves. Violin, piano, and flute instrumentalists benefit most from hypermobile joints. However, other clinicians believe that benign joint laxity will contribute to joint instability. In addition, hypermobile finger joints are more susceptible to structural changes when repetitive forces are applied to fingers. Hypermobility has been correlated with overuse injuries; continued repetitive activity and intense performance can eventually tear ligaments.

Ligament damage can also occur from carrying a load for a long period of time. Inflammation, pain, and joint instability are resulting symptoms. Cello and bass players encounter this problem with their bow arm's thumb. The thumb stabilizes one side of the bow by pinching the frog (the lower end or the bow which attaches the bow's hair to the wood) and bears part of the weight of the bow. Clarinet and English horn instrumentalists have also experienced ligamentous injuries from holding their instruments for long periods.

Compromised ligaments can result in osteoarthritis. With increased joint laxity, articulating bone surfaces will no longer be in alignment. Friction of
surfaces can result in joint degeneration. If the situation is not corrected, the bones of adjacent surfaces can begin to degenerate. Although no studies have been done on the prevalence of osteoarthritis in musicians with overuse injuries, x-rays of case studies have presented evidence of joint and bone degeneration. Small joints of the hands and wrists of musicians are the most critically affected.\textsuperscript{6(p367)}

**Musculotendinous Disorders**

The most common performance related injuries are musculotendinous disorders which include tendinitis, tenosynovitis, and trigger finger.\textsuperscript{3} Tendinitis is the inflammation of the tendon. Usually, the tendon sheath also becomes inflamed and this condition is tenosynovitis. Both conditions result from excessive friction of the tendon on its sheath. Structurally, the tendons of flexor and extensor muscles in the hand pass through tendon sheaths. These tendon sheaths act like fibrous pulleys which are tight but allow some glide with finger and hand movements. Tendinitis and tenosynovitis can occur with repetitive flexion and extension motions of the fingers. Symptoms include localized pain and swelling.

In the thumb, DeQuervain’s tenosynovitis is common with the oboe, the English horn, and the clarinet instrumentalists.\textsuperscript{6(p373)} These musicians bear the weight of their instruments on their thumb. The tendon sheath surrounding the abductor pollicis longus and the extensor pollicis brevis becomes inflamed due to long periods of holding the instruments.\textsuperscript{3(p36)} Symptoms include pain with thumb
abduction and extension and localized swelling over the radial styloid process.\textsuperscript{6(p373)}

Trigger finger can occur when the finger flexor tendons get restricted by their tendon sheath so that the finger joint has difficulty extending.\textsuperscript{28(p85)} This can occur with keyboard and string instrumentalists.\textsuperscript{29}

Muscle Cramps and Pain Disorders

Another common group of disorders are muscle cramps and pain disorders.\textsuperscript{6,12} Initial muscle cramps can develop from lengthy practice and performance sessions. Prolonged muscle exertion, fluid loss through sweat, prolonged muscle shortening, repetitive motions, injury, exposure to extreme temperature, and an electrolyte imbalance are factors contributing to muscle cramps. One pathophysiological theory suggests that during a muscle cramp, the Golgi tendon organ is giving nearly no response due to the shortened position of that muscle group.\textsuperscript{25(p212)} The muscle needs to be stretched so that the Golgi tendon receptor can restore motor inhibition and allow relaxation. Another theory concerning muscle cramping is that peripheral neural stimulation causes ion concentration changes in the blood. A third theory states mechanically distorted nerve terminals with hyperexcitable potentials stimulate muscles to powerfully contract.\textsuperscript{25(p212)} Pain experienced during or immediately following rigorous exercise is associated with muscle fatigue.

Pain also accompanies muscle cramps.\textsuperscript{25(pp212,213)} It is not uncommon to experience pain during or after rigorous instrument playing. Constant overuse of the body can result in micro trauma to soft tissues. Microscopic tissue tears,
edema, and hemorrhage occur. Symptoms include aching, burning, fatigue, and painful muscles. Continuous aggravation of the muscles can result in pain disorders. Finally, if these injuries are not managed, tissue scarring will ultimately limit motion.

Fast repetitive instrument playing is also associated with muscle pain. In repetitive movements, a short time interval between consecutive motions prevents circulation from removing pain producing poor posture, unsuitable instrument fit, and awkward arm positioning can contribute to pain syndromes associated with muscle tension.\(^6(p368),24(p8)\) If these factors are not controlled, muscle and tendon damage will develop into knotted muscles or trigger points. The characteristics of pain syndromes include hardened tight muscles and localized muscle pain occurring on any muscle stabilizing or acting upon the upper extremity.\(^30(p424)\) This includes muscles of the forearm, shoulder, and neck.\(^16(p574)\) Other chronic pain syndromes include fibrocytis and myofacial pain.\(^30(p424)\) Trigger points and sleep disturbances are associated symptoms. Trigger points and tense muscles can also contribute to nerve entrapments.

**Nerve Entrapments and Sensory Disorders**

Nerve entrapments and sensory disorders are a fourth category of performance induced injuries.\(^1(pp570-574),5\) These disorders can occur within the hand or in proximal area with referred neurological symptoms to the hand. Common nerve entrapments include carpal tunnel syndrome, ulnar nerve entrapment, radial nerve entrapment, digital nerve neuritis, and thoracic outlet syndrome. Information on each type of nerve entrapment will include a general
anatomical description of the nerve and area of entrap and the etiology. The musicians who are at risk for the condition will be identified.

Carpal Tunnel Syndrome (CTS)

Carpal tunnel syndrome (CS)\(^{(p572)}\) is one of the most common neurological disorder of musicians. CTS is a median nerve entrapment which occurs in the wrist beneath the transverse carpal ligament. The median nerve is embedded next to nine flexor tendons.\(^{(p9)}\) If any of these tendons become compromised or if inflammation occurs in the carpal tunnel, the median nerve will be compressed.\(^{(p36)}\) Symptoms include night pain in the thumb, thumb pain with abduction or flexion, and tingling or numbness felt at distal interphalanges of digits two to four. Onset is due to long playing periods with hyperextended or hyperflexed wrist positions and repetitive finger motions. Pianists, flutists, and guitarists are instrumentalists who most frequently experience CTS.

Ulnar Nerve Entrapment

Ulnar nerve entrapment is another common type of nerve disorder.\(^{(p573)}\) Entrapment usually occurs at the cubital tunnel (medial posterior elbow). Symptoms include tingling and numbness in the fourth and fifth fingers and loss of motor functions in the flexor carpi ulnaris or the flexor digitorum profundus of fingers four and five.\(^{(p36),(p53)}\) Elbow discomfort can radiate to digits four and five. This condition is most often due to repetitive elbow flexion that causes the ulnar nerve to elongate. The nerve can also be stretched if it slips out of the cubital tunnel. If the ulnar nerve is stretched greater than six percent of its resting length, then its neural blood flow will decrease.\(^{(p54)}\) The reduced neural
blood flow will result in decreased neural conduction and loss of function. The ulnar nerve can also be irritated by localized friction at the elbow with the nerve fixed and unable to glide. Ulnar neuropathy occurs in violists, violinists, pianists, and woodwind instrumentalists.\textsuperscript{32(p47)}

Radial Nerve Entrapment

The posterior interosseous branch of the radial nerve can become entrapped in the hand.\textsuperscript{32(p47)} Entrapment may result in weakness of the finger and wrist flexors and tingling in the thumb. This condition occurs due to static arm positioning and repetitive movements. Usually, no sensory loss occurs. Violinists and violists may experience this disorder.

Digital Nerve Neuritis

Digital nerve neuritis is a less common sensory disorder which occurs in the fingers.\textsuperscript{34(p369)} This condition occurs in musicians who have skin that is unable to form callouses at the tips of the fingers. Pain accompanies pressure on finger tips when the fingers press down on a surface. Some string instrumentalists experience this disorder in their fourth and fifth finger tips from repetitive pressing of the string to the fingerboard. A few flutists have also experienced this condition on their left index finger from tightly grasping their flutes.\textsuperscript{6(p374)}

Thoracic Outlet Syndrome

Thoracic outlet syndrome (TOS) is another common neural entrapment.\textsuperscript{32(p47)} Habits of poor posture, such as rounded protracted shoulders and awkward performance positions, contribute to this condition. Symptoms of
coldness, heaviness, paresthesia, and pain are related to muscular compression of the subclavian artery, vein, and nerve. Symptoms usually radiate through the arm and into the hand. Violinists and violists commonly experience this condition due to static arm positions from holding their instruments.

Focal Dystonia or Occupational Cramps

Focal dystonia, or occupational cramps, involves motor dysfunction which can be disabling. Conditions of pain, tremor, abnormal coordination, involuntary muscle movement, and other dystonic patterns occur with muscle cramps. These and other associated symptoms appear as muscle weakness, involuntary finger curling or drooping, finger fatigue, aching pain, stiffness, paresthesia, finger dragging, finger jerks, and hand or finger shaking. Fred Hochberg has tried to characterize the occurrence of these cramps. He describes them as cramps occurring with one task (simple cramps), cramps with dystonic characteristics which occur with several motions (dystonic cramps), and cramps occurring at rest and in several joints (progressive cramps). Keyboard, violin, guitar, clarinet, flute, and cello musicians experience this disorder. Extended practice periods, over stretching of the hands (such as playing octaves for pianists), and excessive ulnar deviation (such as occurs in guitarists during rapid playing) are a few movement patterns associated with focal dystonia.

The pathophysiology of focal dystonia is not well understood. Most musicians who get this disorder tend to be professional performers or college music majors, and they are usually unable to return to performance. While
this disorder occurs least in comparison to the other groups of disorders, it is the most disabling of all of the disorders mentioned.

These categories of overuse injuries are commonly found by clinicians. The following chapter will present some of the general approaches in evaluating the conditions of musicians with performance related injuries.
CHAPTER III
EVALUATION CONSIDERATIONS

Many clinics operate with a team concept in evaluating and treating the musician with performance related injuries. The basic medical team involves a physician, a physical therapist, an occupational therapist, a music teacher, and often a psychiatrist. During the evaluation session, sensitivity to the personal needs of the musician is necessary. The initial evaluations include the subjective and objective components of general evaluations. Many of these components are modeled from sports medicine and occupational medicine evaluation tools. This chapter will present the information gathered during the patient history, subjective, and objective components of the evaluation. A specific evaluation will also be presented.

Patient History and Subject Components

The history should focus on the patient’s present complaints, past medical history, recent performances, practice sessions, additional activities, and lifestyle goals. Chief complaints experienced by the patient should include descriptions of the symptoms and the associated movements bringing on these symptoms. Symptoms to be investigated include pain, numbness, tingling, muscle cramps, inflammation, and loss of function. Fry uses a five point pain
scale (Table 1) to grade the injury's severity based on pain characteristics. High grades of pain correspond to the greater severity in injury.

Knowledge of a patient's medical history is significant to rule out other underlying pathologies which may mimic or aggravate the injury.\textsuperscript{38(207),3(p66)} When and how the symptoms occur should be recorded. Acute or chronic conditions should be identified. Past medical history includes prior performance related injuries, past traumatic injuries, and illnesses. This information can sometimes differentiate whether the primary cause of the injuries is due to overuse or to other factors. The patient's affect, stress management ability, attitude, and relationship with family members should also be noted in the patient's history.\textsuperscript{40,41,42(p51)} These factors will affect treatment compliance and will be significant in treatment planning.

In addition, the history should include performance and practice habits.\textsuperscript{10(pp117,118)} Information on the length and on the frequency of practice sessions should also be recorded. The evaluator needs to check if the musician utilizes warm up and stretching activities before starting intense instrument playing.\textsuperscript{43} Other factors to notice are changes of music repertoire or musical techniques and performance on a new instrument.\textsuperscript{44(p460)} These changes may contribute to the overuse symptoms if the musician does not gradually adjust to them. Additional activities to be recorded include supplemental jobs, hobbies, and daily lifestyle.\textsuperscript{27(pp33-35)} Information about the patient's general physical condition is important in assessing the musician's physical endurance.\textsuperscript{45}
<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>Pain while playing or for a short period after playing</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Pain that persists for a longer period (hours) after playing</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Pain that progresses while playing and requires the practice sessions to be shortened but resolves between sessions</td>
</tr>
<tr>
<td>Grade 4</td>
<td>Pain that progresses while playing and does not totally resolve between sessions</td>
</tr>
<tr>
<td>Grade 5</td>
<td>Continuous pain that markedly reduces or prevents playing</td>
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The patient goals will direct the clinician in determining the treatment plan for the patient. These goals will be based on the level of performer and the type of instrument he or she plays. The performer’s level may be that of young prodigy, prepubescent music student, adolescent music student, college music major, amateur community instrumentalist, professional soloist, or member of an orchestra or band. Each musician’s needs will vary. In general, all information gathered from the patient history will facilitate the evaluator in diagnosing the primary injury and in developing an achievable treatment plan that will promote success in the patient’s recovery. The patient history is followed by objective assessments of the patient’s physical condition.

Evaluation Objective Considerations

Objective assessments can also discover misuse patterns which may contribute to the musician’s injury. Observing the musician perform can assess functional movements. Many clinics require instrumentalists to bring in their instruments in order to videotape them while they perform. A music teacher may be of assistance to the therapist in this portion of the evaluation. Knowledge of how instruments are traditionally played and the required physical positions will assist the clinicians in the functional assessment. The symptom pattern should be recorded as occurring during or after performing. Signs of fatigue including pain, incoordination, postural changes, cramps, or loss of function should be noticed.
The general physical assessments of posture, range of motion, strength tests, and sensory tests should be obtained. \cite{14,37,46} Postural assessments should be observed in both standing and sitting positions. Head, neck, shoulder, elbow, and hand positions should be observed before and during performance to localize the source of the problem. Hand temperature and symmetry should be observed. \cite{22} Range of motion and strength should also be measured. Range of motion assessments should include passive testing, active testing, and hypermobile joint movement. \cite{22} Kai-Nan An and Fadi Beijani\cite{46} have developed guidelines for wrist range of motion standards which performers should not exceed in order to perform in a comfortable position. These recommendations include 60° of wrist extension, 54° of wrist flexion, 40° of ulnar deviation, and 17° of radial deviation. An and Beijani also identified a baseline standard for isometric hand strengths; range of motion; finger pinch; hand grasping; finger flexion, extension, abduction, and adduction; wrist flexion and extension; and wrist radio and ulnar deviation. The evaluator should check if neurological or musculoskeletal symptoms are reproducible. \cite{22} Assessments should also include tests for tendinitis, neuropathies, shoulder and scapular musculature imbalance, spinal limitations, and hand intrinsic and extrinsic musculoskeletal imbalance. Observations of daily functional activities should also be observed.

Work environments should be assessed for their potential contribution to problems. \cite{14,47-49} Space, lighting, and music stand and chair height will affect the musician’s overall posture. The clinician should observe the patient’s posture in the position required for performance. The instrument should fit the musician
without compromising good posture. The patient is encouraged to adjust to better fitting positions to reduce tension or to improve posture. The effectiveness of any adaptive or orthopedic equipments also need to be assessed. The musician's ability to transport the instrument should also be assessed and considered as a potential factor contributing to the musician's condition.

In addition, an evaluator may want to use the expertise of instrument technicians. Sticky or loose keys, loose strings, excessive key or string vibration, and badly tuned instruments are factors which can contribute to any of the overuse injuries which musicians experience.

Other commonly used objective tests which assist the evaluator are nerve conduction tests, EMG tests, x-rays, and MRI. Neurological conditions can be assessed through nerve conduction tests. Muscle activity can be observed through EMG tests. Joint structures can be observed from x-rays and MRIs.

Special tests are commonly used to diagnose the primary injury. Certain special tests should be done to rule out prevalent injuries associated with each type of instrumentalist. Instrumentalists with the most notable performance related injuries are the keyboard musicians, string instrumentalists, guitarists, and woodwind players.

Keyboard Musicians

The keyboard musicians can be affected physically by poor seating posture. They should be checked for slouching which can lead to musculoskeletal problems or neurological entrapments originating from the neck or shoulder. Those who have joint hypermobility or arthritis should have a music
coach check their technique for excessive force when striking the keys during staccato passages, chords, or octaves; excessive force contributes to hand pain or finger buckling. Carpal tunnel special tests, such as Tinel’s and Phalen’s, should be assessed. The evaluator can observe for any excessive hand stretching or wrist ulnar or radial deviation the musician may use in order to reach for octave or chords.

String and Guitar Instrumentalists

Left hand pain and muscle fatigue are common among string and guitar players. The violinist and violist must endure long periods of positioning their left arm in a supinated position in order to hold the instrument. The evaluator should check for any excessive ulnar or radial deviation with the left hand. Finger joint instability should also be checked. The evaluator should observe if any joint laxity causes these musicians’ left hand distal interphalangeal joints to buckle or hyperextend when the fingers compress the strings or during vibrato. Signs of thoracic outlet or cervical muscle imbalance should also be investigated for all string and guitar musicians.

The shoulder and chin rests of violinists and violists should be checked for proper accommodation of the musician’s neck length. Cellists have problems with right thumb pain due to the weight of their bows and the horizontal positioning of the bow on the string. Testing for ligament problems in the thumb should be performed.

Guitarists experience injuries from their left wrist being in a flexed position in order to form chords on the fingerboard. Tests for carpal tunnel
syndrome, ulnar neuropathy, and thoracic outlet syndrome should be applied to rule out any nerve entrapment caused by this awkward position. Another sign of overuse is blisters on the finger tips which occur from long unaccustomed periods of practice or performance.  

Woodwinds

The clarinet, oboe, and English horn instrumentalists are prone to thumb pain from DeQuervain's tenosynovitis. Their right thumbs support the vertical weight of their instruments when playing. Special tests to rule out DeQuervain's tenosynovitis should be applied. The effectiveness of the placement of the thumb rest and the use of a shoulder strap to assist in bearing the instrument weight should be observed. It should be noted, however, that some musicians have developed neck and shoulder problems as a result of the neck strap transferring the instrument's weight from the thumb to the neck.

In general, these evaluation considerations have focused on musicians who develop injuries from performance, and not on pathological disorders. These evaluation considerations are the preliminary assessment in developing the treatment plan for the musicians. They should also be used when reassessing the patient during the treatments. The following chapter will address the treatment of the musician with regard to the evaluation considerations mentioned in this chapter.
CHAPTER IV
TREATMENTS OF PERFORMANCE RELATED INJURIES

Treatments for performance related injuries have relied on sports medicine and occupational medicine approaches.\textsuperscript{17,36,46} The treatment goals focus on reducing inflammation, relieving pain, regaining strength, and preventing further injury. The ultimate treatment intent is to have the musician return to his or her prior performance level and to prevent reinjury. Many clinicians base their treatment protocols upon effective results from longitudinal case studies of similar patients.\textsuperscript{53,54} Their treatment approaches include general conservative treatments of rest, modality applications, exercise, music retraining, adaptive devices, ergonomic recommendations, and relaxation techniques. Each of these treatment aspects will be discussed in this chapter with regard to stages of rehabilitation. In addition to treatments of injuries, injury prevention will also be discussed.

Rest Treatments

During the acute phase of rehabilitation, most clinicians initially focus on rest appropriate to the severity of the injury.\textsuperscript{10(p118)} Rest is a critical component of treatment as it allows damaged structures to heal. With rest, inflammation, pain, tingling, numbness, and other symptoms begin to resolve.
Rest is one of the most effective components of treatment in returning the patient to pain free performance. Based on a study by Fishbein et al.,\textsuperscript{14}(p92) 84% of the musicians who temporarily stopped playing their instruments because of music related injuries were successful in resolving their pain. Fry applied two types of rest protocols to groups of musicians with injuries. Both protocols had an 87% success in returning musicians to pain free performance.\textsuperscript{17}(p273) These two basic types of rest treatments, absolute (radical) rest and relative (modified) rest are also advocated and implemented by many clinicians.

Absolute Rest

Absolute or radical rest involves total abstinence from instrument playing. This type of rest is recommended for patient's with severe, continuous pain which occurs even when the musician is not performing.\textsuperscript{14}(p278),28(pp76,77),55(p357) In addition to performance restrictions, musicians are encouraged to modify and decrease activities of daily living that may aggravate their condition. Musicians should avoid activities involving fine pinching, forearm twisting, and wrist deviation.\textsuperscript{18}(p278) Some musicians have had friends assist them in organizing and doing restricted activities. Some clinicians recommend patients wear immobilizing splint when sleeping. Fry\textsuperscript{19}(pp278,279) recommends informing the patient that sometimes sharp pain from adjacent areas may occur during the first three weeks of rest, and that the pain can fluctuate from day to day. A daily recording of pain intensity and duration should be compared with the previous week's best result. In addition, Fry believes issues affecting patient compliance need to be addressed in order for the rest treatment to be successful. These
issues include the patient's feelings toward loss of activity, dependency on others, and feelings of depression regarding his or her condition. Clinicians should give reassurance to the patient based on progress, utilize support from patients at more advanced rehabilitation stages, and refer the patient to counseling. Fry also believes that musicians who do not follow the guidelines of this treatment will likely aggravate their condition. Unresolved acute conditions will eventually become chronic conditions. Finally, injury management focused on total resolving injuries is more beneficial than maintaining chronic conditions.

The duration for absolute rest will vary based upon the individual's condition. When the musician's pain has disappeared or is minimally felt, the individual begins simple short duration exercises. Eventually, an exercise program of gradually increasing periods of activity is included. At this stage, the musician usually progresses to a modified rest rehabilitation treatment.

Modified (Relative) Rest

Modified rest or relative rest treatments reduce instrument playing time to a level where no pain is produced. The presence of pain is a measurement of the degree that the musician's physiological structures can tolerate activity.

Modified rest is more commonly applied than absolute rest, especially with musicians who have regular schedules or are on tour. Some clinicians feel that absolute rest is too restricting and will result in neuromuscular loss. Nicholas Quarrier recommends mental practices involving visualization of performance as a substitute practice technique. Musicians should monitor their
activity and pain levels by using a diary or log of practice time and physical discomfort. The general criteria for restriction of activity is to perform at a duration and intensity that is pain free. If pain is not effectively controlled with a modified rest, absolute rest will be prescribed.

**Analgesic Medication**

Combined with rest, clinicians have prescribed various analgesics drugs to control inflammation and manage pain. The more common types of pain relieving drugs are nonsteroidal anti-inflammatory medications, muscle relaxants, and analgesics or pain killers. These treatments may be administered through oral intake, needle injections, ultrasound, or iontophoresis. Richard Norris support the use of nonsteroidal pain relievers during the acute stages, but not beyond a three- to four-week duration. He believes that the long term use of oral analgesics could bring on gastrointestinal side effects or bleeding disorders. In addition, Norris does not believe that analgesic drugs alone will cure injuries.

Other clinicians will not recommend the use of any drug since it will alter the pain pattern and mask the injury’s symptoms. In addition, some medications, such as tranquilizers and muscle relaxants, cause drowsiness, decreased motor control, and decreased coordination. These clinicians wish to monitor the patient’s condition based on the experienced pain patterns.

**Treatment Modalities**

During the subacute phase, physicians have prescribed treatment modalities to facilitate healing and further relieve pain and discomfort. Treatment modalities include heat, cold, manual, and mechanical therapies. Heat
treatments include ultrasound, hot packs, paraffin, fluidotherapy, and whirlpool. Heat increases soft tissue extensibility, relaxes muscle, and facilitates metabolite clearance. Cold treatments include ice massage and ice packs which reduce pain, inflammation, and muscle tightness during the acute stage of injury or after a rigorous performance.

Manual therapy includes soft tissue and deep tissue massage, joint mobilization, and manual traction. Massage facilitates nutrient delivery to the injury site, relaxes muscles, and breaks up adhesions. Joint mobilization opens restricted joint spaces and facilitates nutrient delivery to the injured joint site. Clinicians will use a variety of these modalities as suits the patient's situation and condition. These modalities also prepare patients for stretching and exercises. The combination of modalities, analgesics (if indicated), and exercise programs enhance healing of most performance related injuries. However, occupational palsy disorders have not responded with any success to any modality treatment.

Exercise

Exercise is another modality which assists in returning an injured person to function. Exercise physically strengthens and conditions the individual. Well planned exercise programs have resulted in correcting muscular imbalances, improving posture, reducing musculoskeletal pain, elevating moods, and reducing tension. Generally, the injured musician's exercise program consists of a warm up period, general strengthening exercises, stretching exercises, and a cool down period. The warm up and cool down periods involve gradual slow movements, range of motion, and stretches. Warm up exercises
are done to improve muscle contractility. Cool down exercises are done to relax muscles and slow cardiovascular activity after an intense performance. The general strengthening exercises focus on light weight general conditioning and less on intense muscle strengthening. Clinicians recommend no resistance with exercise for individuals with severe injuries such as focal dystonia. Some clinicians who believe in the overuse theory feel that hand muscles do not need as much strengthening as do proximal shoulder and scapular muscles which affect the individual’s posture. They believe hand muscles need to be preserved rather than overused. However, many clinicians will recommend isometric strengthening of the intrinsic hand muscles for musicians with finger joint hypermobility or laxity.

Exercise is also utilized in maintaining weight and cardiovascular conditioning. Maintaining the individual’s weight will reduce loading on nerve and muscles. Cardiovascular conditioning will increase the musician’s physical endurance for intense performance. Alice Brandfonbrener reports that the musician will benefit more from endurance types of sports involving coordination rather than heavy weight lifting. Swimming, racquet sports, and light weight lifting may be recommended sports. Some physicians will warn musicians about sports that have high risks in jamming a finger, such as basketball and volleyball. Although one cannot stop younger musicians from participating in sports of their choice, therapists can advise them on the injury risk potential of the sports.
Relaxation Techniques

Performance anxiety is a major factor which can contribute to muscle tension and incoordination. The musician should, therefore, train in relaxation programs to reduce excess muscle tension and develop motor coordination. Techniques such as the Feldenkrais method, Alexander technique, and the Pilates technique have resulted with some success in reducing muscle tension and improving motor coordination. These techniques utilize relaxed coordinated movements which often involve sequences of motions. These techniques also increase the musician’s flexibility. The benefits of these techniques apply to all types of injuries experienced by musicians. These techniques also prepare and facilitate the musician in instrument retraining.

Music Retraining

Music training involves progressive physical conditioning and music repertoire development. During the musician’s retraining, the therapist who is familiar with music can develop an activity schedule for the patient. If the therapist is not familiar with music training, he or she can refer the patient to a music coach.

There are multiple forms of music retraining programs; most utilize sports medicine principles because of the limited research applied to musicians’ injuries. Fry presented one protocol in his study to establish an effective treatment protocol for musicians. He starts his patients with three sessions of two to five minutes of five-finger scales on a desk. Eventually, patients progress to a light touch keyboard. The duration and the number of sessions are
gradually increased as the patient is able. Once the patient reaches four sessions of 10-minute exercises, a C major scale is begun. Speed is now incorporated into the program. The patient increases the speed by 10 seconds per day. Once 15 minutes of exercise is tolerated, the patient begins playing his or her specific instrument. A music coach is utilized to begin music retraining with simple pieces and to develop music techniques.

Fry also uses the sports medicine criteria of gradually increasing performance time by 5% to 10% per week. Practice sessions should not exceed 20 minutes for at least six months. Rest sessions between practice sessions are also at least 20 minute. Even after the musician is recovered, the practice session duration should not last longer than 30 minutes. Exercises and retraining programs are often facilitated by adaptive devices and instrument adjustments.

Adaptive Devices and Instrument Adjustments

Adaptive devices have been prescribed to aid the musician in resting, reduce stress from static positioning, limit movement of the injured extremity, provide a better ergonomic fit between the musician's body part and the instrument, or facilitate good posture. Devices include splints or orthoses, performance assistive devices, and activities of daily living assistive devices.

Orthotics prescribed to injured musicians include resting splints and dynamic orthoses. Hand and wrist resting splints are prescribed early in the treatment to restrict movement during rest treatments. Splints
which limit movement and assist with reducing inflammation include the ring orthosis for restricting the interphalangeal joints of the fingers and the wrist hand orthosis which restricts wrist motions and stabilizes the hand. These devices should be used only until inflammatory symptoms resolve.

The dynamic orthosis is prescribed to musicians who are following a relative rest treatment program. Orthotics such as the thumb opposition orthosis, volar wrist-hand orthosis, and ring finger orthosis are used by musicians as functional splints which provide support or restrain unwanted movements, yet permit enough range of motion for performance. Some of these dynamic orthoses allowed muscle strengthening with their outrigger attachments.

General guidelines for the use of orthoses include developing a progressive wearing schedule and monitoring the skin for pressures sores. Additional guidelines include adjusting the orthosis or decreasing the wearing time if skin irritation or skin redness develops. Skin breakdown can be reduced if the skin is kept dry and clean.

In addition to orthotics, adaptive devices for specific instruments facilitate performance. An adjustable thumb rest can be attached to the clarinet to minimize the static loading on the thumb which holds the instrument. This device has prevented the reoccurrence of de Quervain's tenosynovitis for clarinetists. Some cellists have switched from French bows to German bows to prevent excessive loading to the thumbs. The French bow is supported by the right hand's thumb, second, and fifth digits. The thumb acts as a fulcrum between the second digit and the fifth digit. It bears the bow's weight. The German bow is
supported in the supinated palm of the right hand with fingers wrapped over the frog of the bow. The flutist can use flute mouthpieces which are designed with a 30° bend at the end of the lip plate. Unlike the traditional mouth pieces which required the head to tilt and rotate 30° to 40°, this design allows the neck and head to be at a neutral position and prevents neck injuries. Adjustable air blown shoulder rests for violas and violins have aided the musician in reducing pain in the left shoulder and neck muscles. Straps reduce static loading to the arms of guitar players.

In addition to adaptive devices, some instruments can be adjusted to ergonomically accommodate the musician. Flutes can have their keys repositioned to fit the musician's natural tenodesis. Clarinet keys can also be modified to accommodate the musician with restricted finger independence of the fourth and fifth digits during flexion. The valve of French horns can be lengthened to increase finger leverage or widened to allow better finger contact. New designs for guitars and violas give the musician's hand easier access to music notes played near the body of the instrument. Some bass fiddles are designed with a greater slope to the instrument's shoulder to allow easier reach for high notes close to the instrument's body or better arm reach for short musicians. Another aid that reduces static loading is the end pins at the bottom of instruments, such as the cello, the bass oboe, and the tuba. These end pins are adjustable and they serve to support some of the weight of the instruments.
Besides using adaptive devices during performance, musicians have also used adaptive devices to assist their activities of daily living. Some of these devices include built up pencil and pen holders to increase pinch grip diameter, thicker steering wheel grips, jar openers, and ergonomically adjustable keyboards.

Education

Education is essential in explaining the nature of the musician's conditions and in presenting the general guidelines of treatments for injury management and prevention. In addition, factors contributing to the injury, ergonomic recommendations, and hand preservation techniques should be taught.

Ergonomic recommendations focus on self management and the use of the most efficient and effective methods of doing an activity in order to prevent injury occurrence. They focus on posture and seating considerations. Seating should be adjusted so that feet are planted on the floor without causing the individual's back to slouch. The music stand should be at a height so the musician's head is minimally tilted down or rotated away from midline. The stand should be within arm reach so the musician can turn the page without having to lean forward. The musician should not practice in cramped areas. The instrument size should fit the person.

Hand preservation recommendations include playing with warm hands and trying to perform activities with the hand in a neutral position. Musicians should choose music pieces with techniques that are possible to
master without straining one's hands. Small hands should avoid music requiring excessive finger abduction, wrist ulnar or radial deviation.\textsuperscript{22(p64)} The general guideline is to have environmental conditions and playing techniques fit the musician's physical characteristics.

In general, musicians with performance related injuries should begin to respond to the mentioned forms of treatments within three to four weeks.\textsuperscript{38(p208)} If no improvement occurs within this time period for musicians with nerve entrapments or tendinitis, the musician may need to be referred to a physician for surgical treatment.

Musicians have had success with other forms of nonconventional treatments, such as chiropractic treatments and acupuncture treatments. Regardless of the form of treatment, the most cost effective treatment is education for the prevention of injuries.\textsuperscript{52} The role of the physical therapist has become one of actively educating musicians and music educators in postural considerations, ergonomic recommendations, and safe and effective hand care for the prevention of performance related injuries.\textsuperscript{22}
CHAPTER V
CONCLUSION

Music performance related injuries develop from repetitive activities, lengthy performances or practice sessions, improper techniques, poor ergonomic conditions, poor posture, and poor body mechanics. They have been classified as overuse or misuse injuries. Clinicians have also paralleled musicians to athletes and workers in training intensity, performance requirements, and awkward task positions. Combined music and medical teams have developed with the growing recognition of performance related injuries of musicians.

From the research of multiple clinicians, etiological factors have been identified. Performance related injuries are prevalent with middle age adults and adolescents. The hand is the most frequently affected body part as it has the most frequent contact with objects of functional activities. It is also affected by various forms of instrument playing, arm and hand positioning, and trunk posture. Musicians playing keyboard instruments or string instruments have the highest occurrences of overuse hand injuries.

Clinicians, in an attempt to understand performance related injuries, have categorized them as bone and joint injuries, musculotendinous disorders, muscular cramps and pain disorders, nerve entrapments, and focal dystonia or
occupational palsy disorders. Of these, musculotendinous disorders and pain disorders are those most frequently found in musicians. Nerve entrapments are the second most commonly occurring group of injuries. Focal dystonia disorders are the least frequently occurring group of injuries; however, they are the most disabling. Clinicians recognize and use these categories to evaluate, diagnose, and treat the conditions experienced by musicians.

The evaluation process focuses on diagnosing the primary injury and recognizing the contributing factors. Information gathered will assist the evaluator in developing a workable treatment plan. Two main parts of the evaluation include the extensive patient history and the objective assessment. The patient’s history includes subjective information about the symptoms presently experienced, past medical conditions, music habits, lifestyle, and the person’s physical condition. The objective assessment includes general assessment tests, instrument assessment tests, and report of diagnostic tests. Both the patient’s history and the patient’s objective assessments will facilitate the evaluator in developing treatment goals and methods for restoring the musician to his or her prior asymptomatic, functional status.

The treatment of each musician is unique to the individual’s condition and need. The information gathered from the evaluation should direct the clinician in the selection of treatment approaches. The general treatment approaches include rest, pain controlling medications, treatment modalities.
music retraining, exercise\textsuperscript{14,17} adaptive devices, instrument adjustments, and
education for injury management and prevention.

Each of the aforementioned treatments have found some success\textsuperscript{53,54} however, reports of results have been inconsistent and vague. In addition, treatments can last as long as a year or more. The accumulating costs are a consideration in the treatment of musicians. Some musicians may not have medical insurance or are unable to afford the various forms of treatments.\textsuperscript{6(p367)}

Prevention appears to be the key in minimizing injuries and the treatment costs. Some physical therapists have addressed this issue by providing educational inservices to musicians and music educators\textsuperscript{22}. They address the benefits of good posture, proper body mechanics, well planned practice schedules, generalized conditioning, good instrument fit, good ergonomic conditions, and efficient playing techniques.

In general, this paper addressed the most common disorders, the evaluation considerations, and the treatment aspects of performance related injuries to the hand, such that the physical therapist has increased awareness of these injuries. There are other aspects, however, that can also affect the performance abilities of musicians, such as genetic and disease conditions. These were not addressed in this paper, but can be further investigated by the reader. Finally, future research is needed to develop biomechanically efficient movements unique to each instrument for the prevention of overuse conditions.
APPENDIX A
REFERENCES


