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December 15th, 2006

Dear Judith Katz, Rita Rudo, Leanne Webb, Sue Burley, and Lisa McCaskell,

As you had requested, this report reviews the ergonomic risks and provides recommendations for the ultrasound technologists.

We would like to thank all of the wonderful staff that were so helpful and open with us during our assessment, especially Leanne Webb for handling our offsite questions and ensuring the questionnaire was administered and delivered back to us. We would also like to acknowledge the assistance and expertise of Helen McRobbie.

If you have any questions, please do not hesitate to contact us. We look forward to meeting with you again soon.

Sincerely,

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ERGONOMIC REPORT FOR GREY BRUCE COUNTY

Addressing the Ergonomics for the Sonographers

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December 15th, 2006

Recipients:
Judith Katz (JH&SC management representative)
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Leanne Webb (Radiology Manager)
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1.0 INTRODUCTION

1.1 OHCOW

The Occupational Health Clinics for Ontario Workers (OHCOW) is fully funded by the Workplace Safety and Insurance Board (WSIB) and is focused on the prevention of occupational illness and injury. There are five clinics across the province of Ontario, and each clinic employs a team of occupational health professionals including ergonomists, hygienists, occupational health nurses, and physicians. One of the primary mandates of the clinics is to provide a group consultation service to joint health and safety committees.

1.2 Background Information

I (Laura) was initially contacted by Leslie Piekarz (Executive Director of the Toronto OHCOW clinic). Leslie had been in contact with Lisa McCaskell (OPSEU Health and Safety rep) in organizing a province wide, five site, ergonomic review. I was given Leanne Webb's contact information (Radiology Manager) to arrange for a date/time of the assessment. After our initial conversation, it was decided that our visit should be delayed until October 2006, since the Owen Sound hospital was changing their system over to PACS (filmless technology) which would alter the way the work was to be performed.

On October 4th and 5th, 2006, Laura Munro Martin (Ergonomist) and Michelle Tew (Occupational Health Nurse) met with the Owen Sound Ultrasound Technologists to review the physical demands within their job. On October 5th, we also visited and reviewed two additional locations in Meaford and Markdale. These visits were followed up with a work health questionnaire in late October to collect more information. The completed questionnaires were received in mid November, 2006.

1.3 Objective

This report has been written to address the following four objectives:

1) To provide information on ergonomics and injury prevention,
2) To provide a description of the job and the demands placed upon the sonographers,
3) To identify and explain the areas of concern that may potentially present an increased risk of injury to the sonographers, and
4) To provide recommendations geared towards decreasing the worker's risk of injury.

It is important to note that this report is not a physical demands analysis nor does it address all of the injury risk factors present in the workplace (e.g. psychosocial, occupational hygiene issues).

1.4 Workplace Description

Grey Bruce Health Services is comprised of one speciality hospital in Owen Sound, five rural hospitals in Lion's Head, Markdale, Meaford, Southampton, and Wiarton, as well as one smaller clinic in Tobermory. Among these locations, Owen Sound employs seven technologists, with the smaller hospitals often staffing only one to two workers.

The smaller locations did not offer all of the same services that were performed in Owen Sound and they had not been transferred over to the newer PACS system.

The workers informed us that the majority of the locations were equipped with similar equipment with the exception of Markdale. This facility had a newer ultrasound machine which the workers found to be much more user friendly and comfortable to use. This machine was afforded because of local fund raising efforts in the community.

1.5 Applicable Standards and Guidelines

In Ontario there are no explicit ergonomic standards. However, a "general duty" clause exists in the Occupational Health and Safety Act, section 25 (2)(h) which states that, "an employer shall take every precaution reasonable in the circumstances for the protection of a worker." In addition, the Industrial Regulations, section r-45(a) require that "any lifting task should not endanger the safety of any worker".

Due to the complexities within the job of the sonographer, there are very few appropriate tools that can be used to assist in quantifying the injury risk for the worker. Therefore, for the majority of the injury risks and concerns within the job and specific tasks have been described and not measured.

2.0 METHODS

During the review, we spoke with each worker regarding their set-up and their musculoskeletal complaints. Several measurements, a videotape, and pictures of the work environment and the workers were taken (i.e. this was only done upon the approval of both the worker and the patient).

The tools used during these assessments included:

- tape measure,
- digital camera, video camera
- force gauge (omni 200)

This report uses the revised Snook tables to help illustrate the workers' risk of injury when pushing and pulling ultrasound machines and other miscellaneous equipment. These tables are based on psychophysical criteria, and output maximum acceptable weights and forces for lifting, lowering, pushing, pulling and carrying which are specific to the task conditions, and the population specified (i.e. percentile and gender), in order to assist in designing jobs around reducing the risk of developing low back pain.

It is important to note that although this tool has been validated, and is widely used within the ergonomic field, it does come with certain limitations. This tool has only been used to assess a single task. A multiple task assessment has not been performed. If you have any questions about this tool or would like more information, please feel free to contact us.

3.0 BACKGROUND

3.1 Ergonomics & Musculoskeletal Disorders

Ergonomics is the science of designing the work to ensure the worker is safe, healthy, effective, and comfortable and it is often described as fitting the job to the worker. The primary goal of a properly designed, or "ergonomic" job is to prevent injuries and maintain optimal health in the worker.

The types of injuries which occur from poorly designed jobs are often called work-related musculoskeletal disorders (MSD). This term refers to several types of insidious injuries which occur over time and if ignored progress from symptoms of fatigue, to discomfort, to pain and finally to a chronic injury (e.g. tendonitis, low back pain…). The goal of ergonomics is to prevent this progression by designing jobs properly. We also encourage workers to listen to their bodies so that they can pick-up on the early signs of injury so that the stressors in the environment can be properly addressed.

There are several factors in the workplace which may contribute to a worker's symptoms of fatigue and discomfort including:

- physical (e.g. equipment & technology, work area design),
- organizational (e.g. workload, job duties, work hours),
- psychosocial (e.g. stress, co-worker support), and
- environmental (e.g. indoor air quality, lighting)

In addition to these factors, each worker is unique and therefore has their own strengths and weaknesses (e.g. previous injuries, strength, fitness level, current health…) which all contribute to an individual's injury risk.

3.2 Job Description

The job description for the Sonographer was provided by Leanne Webb and this report stated that there were four primary areas of responsibility:

1) Performing ultrasound examinations (70% of the time) - The patient is brought into the room and which will be set-up to accommodate the type of exam being performed (e.g. proper bed cut-outs used, proper transducers hooked-up, sheet covering bed…). The exam is then explained to the patient who is properly positioned on the table. The sonographer performs the scan (i.e. this takes the majority of the time and each worker we observed seemed to have their own style and preference for various exams (sit vs. stand)). After the scan is completed, the sonographer writes up the case and scans it into the system (scanner was located beside the computer monitor). The information is checked on the computer to ensure everything is entered properly (i.e. this is the new PACS system). This final process of writing, entering, and checking the report takes between 5 to 15 minutes (i.e. with the longest times being for the obstetric exams). The sonographer is also required to assist the radiologist with various invasive procedures.

2) Patient care and unit responsibilities (15% of the time) – this involves ensuring the patient is properly prepared and informed; maintaining patient confidentiality; providing patient care and safety; ensuring the room/equipment is properly cleaned and stocked…
3) Clerical duties (5% of the time) – this involves such tasks as preparing general requisitions; obtaining films from the library or from other computer sources, phoning patients…
4) Quality assurance and safety/health (5% of the time)

The description provided (as summarized above) appeared to accurately summarize the duties of the sonographer. The only exception is the percent of time spent performing the ultrasound examinations. The workers in Owen Sound estimated that approximately 80% of their time is spent scanning, not 70%. This increase in scanning time is due to the improved efficiency of the new PACS system. The sonographers in Owen Sound stated that they perform an average of 13 to 15 scans each day. The following is a list of the average amount of time required for various examinations:

- abdomen (30 minutes), abdomen/pelvis (45 minutes), abdomen/pelvis/TV (60 minutes), pelvis/TV (30 minutes)
- breast, pelvis (both take 15 minutes)
- obstetrical high risk (60 minutes), obstetrical early (30 minutes),
- musculoskeletal, thyroid, prostate, scrotum, cranium, popliteal fossa (all take 20 minutes),
- arterial doppler (60 minutes),
- venous doppler, carotid doppler (both take 15 minutes),
- interventional biopsy's (45 minutes)

The external sites run their operation a little differently because they have not yet been transferred over to the PACS system, therefore they are required to handle more films and fill out more paper work. They also do not perform all of the procedures listed above.

3.3 Work Area Description

Each ultrasound area is equipped with a bed, an ultrasound machine, a computer, a table, a chair, a stool, and a garbage bin. The storage for necessary items in each room is kept in the computer stand, and around the ultrasound machine. Occasionally the sonographers perform exams at the bedside (e.g. in the neonatal unit), or on patients from typical hospital stretchers. The following bullets describe each of the primary pieces of equipment in the rooms:

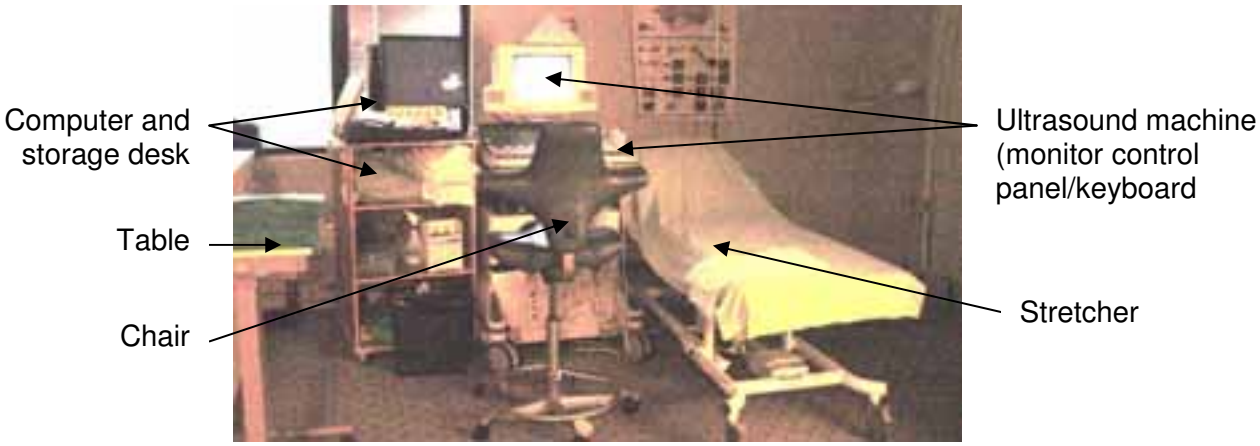


Figure 1: This figure displays the typical work area set-up

Exam beds:

- The beds were designed by a sonographer and therefore fit the job duties very well. All the workers we spoke with appreciated the smart design (e.g. the bed had cut-outs to be removed for easy access during certain exams, the height adjustment was easy to use, and the side of the bed even had a cut-out/contour shape to it which allowed the sonographer to get close to the patient).
- The one problem mentioned with these beds was the locking system. Each wheel had an individual lock and some of the mechanisms had a very short action and were difficult to activate (i.e. the metal brakes were more difficult to use because of the smaller top part to let go of the brake).

Ultrasound machine:

- The machine in Markdale was a newer version and the workers who used it found that it was much more comfortable and user friendly machine to work with. This was because of the tremendous amount of adjustability it afforded. Some of the major benefits included the:
  - adjustability of the monitor and the control panel which moved <u>separately</u> from each other in all directions,
  - higher monitor resolution and clarity,
  - compact, easy to navigate control panel,
  - touch screen for shortcuts/frequently used annotations, and the
  - keyboard slid in and out from underneath the panel.

Figure 2, 3 and 4: These figures show some of the features on the newer ultrasound machine in Markdale (i.e. the adjustability, keyboard design, panel and touch screen layout).

- Unfortunately the majority of the ultrasound machines had both a fixed monitor and keyboard/control panel. These were older machines and provided no adjustability to the sonographer and also had a poorer screen resolution. The control panel had a 25" width, 17" depth, was 37" high to the front edge of the panel, and 47" to the bottom of the monitor. The monitor was 8" tall by 10.5" wide.

Figure 5 and 6: The ultrasound machine model as shown above is the ATL 5000 (commonly used machine in this system).

Computer:

- The computer was used to check patient records (e.g. previous exam results) and also to enter the information from the exam which was just performed. (The Owen Sound hospital just switched over to this system and the other sites will be following.) It typically sat on a storage table due to the lack of space (this was often a fixed wooden table). (A typical table measured 41" high and 22.1" wide.) The Owen Sound monitors were 19". This computer sat on a separate workstation a few feet away.

Table:

- The table was a simple, wheeled, height adjustable table (similar to the ones used at the patient's bedside for meals etc) and was often used for writing on and helping to position a patients arm or hand while scanning. (The table was 33" across and 13.5" deep.)

Chairs:

- The most common chair used in Owen Sound (HAG chair) was designed with a contoured, wing shaped back. This would allow the user to use the support for their back or by supporting their front (i.e. with their torso leaning forward resting on a support). Many workers commented that they preferred these chairs, as they also lent some arm support if positioned in certain ways.
- Some workers preferred to stick with the traditional, simple raised task chairs. And some of the smaller sites were not provided with the newer style chairs as of yet.

Figure 7, 8, and 9: The first two figures to the left show the newer contoured, wing shaped chairs and the figure to the right shows a typical raised task chair.

3.4 Literature Summary on Injury Rates among Sonographers

Several studies have shown that sonographers have a significant risk of developing work-related musculoskeletal disorders. A very large survey in the mid 90s, which investigated the prevalence of musculoskeletal disorders among registered sonographers in the US, found that 81% of all respondents reported pain and discomfort (response rate (rr) = 32.8%, 983 respondents), with >70% reporting discomfort in the neck and shoulder, >60% in the wrist, lower back, hands, and fingers, and >40% reporting eye discomfort. The specific activities of "manipulating the transducer while sustaining applied pressure, shoulder abduction, and sustained twisting of the neck/trunk were pointed out as the key activities that aggravated the pain and discomfort." (Pike et al, 1997)

To complement this finding I have included the findings from three Canadian studies which were performed from the mid 1990s to 2004. All of these studies have shown an elevated level of MSD complaints among sonographers and are described below:

A survey which focused on the injury profile of sonographers in Alberta in the mid 90s, found that almost 90% of the respondents (n=100, response rate= 61.5%) reported work-related symptoms. These complaints tended to fall into three categories:

- *"neck (48%) and interscapular pain (54%),*
- *shoulder or upper arm pain (53%), hand/wrist pain and low back pain (38%), elbow pain (24%), clumsiness of the fingers(12%), and numbness or tingling (28%), and*
- *frontal headaches (19%) and visual disturbances (redness 34%, blurring 13%, pulling of eyes 12%)."(Wihlidal et al, 1997)*

A survey which was initiated in BC (91% rr) and expanded to include all of Canada (39% rr) found the areas of pain which were most often reported included the shoulder (76%), neck (74%), wrist (59%), back (lower and upper) (58%), and hands/fingers (55%). (Murphy et al, 2000)

And finally, Winnipeg researchers administered a survey to 76 sonographers in an effort to assess the problem of work-related MSD with the goal of "improving working conditions and retaining workers". Through this survey they found that "91% of the respondents (88%rr) reported having had pain or discomfort associated with work tasks since they began scanning…and that this pain affected 77% of workers in their activities of daily living" (e.g. doing household chores). The reported areas of discomfort were as follows shoulder (78%), neck (71%), upper back (61%), hands/fingers (55%), wrists (52%), eyes (42%), mid back and low back (40%) and upper arm (34%). (Muir et al, 2004)

4.0 FINDINGS

4.1 Work Observations and Worker Comments

Over the two days we observed several procedures. The following is a description of the postures and forces we observed while the sonographers were scanning. (Please note that the techniques used by each worker vary drastically and many scans can be performed both seated and standing.)

General Body Scanning Postures: (with the typical ultrasound equipment)
All the sonographers we spoke with stated that they made every effort possible to properly adjust the bed and chair (if necessary) for each patient to help reduce the awkward trunk, shoulder and arm postures.

- Support: The workers chose several positions to scan which included sitting, standing, standing and leaning against the bed, and sitting on the bed with the patient. The majority of the workers preferred the newer chairs although none of these workers were observed using them to support the front of their torso while leaning forward.
- Neck: The neck primarily adopted a posture of flexion (the degree varied depending on the height of the sonographer or the height of the chair), and 60º of rotation to view the screen. The worker would also repeatedly turn away from this position to look at the patient. This required the sonographer to rotate their neck the other way, towards the patient. This movement and altered neck position was held for a very short period of time (i.e. usually only a couple of seconds) and was performed routinely throughout the examine.
- Torso: The sonographers often adopted static postures of forward and lateral flexion (i.e. leaning in towards the patient) while twisting slightly to the left.
- Right Scanning Shoulder and Arm: The right shoulder was abducted to various degrees depending on the distance of the reach (observed postures of up to 70º abduction). Flexion of the shoulder to various degrees was also regularly seen. The scanning postures were often held for extended periods of time, usually with very little support for the arm. (The support the sonographers typically used was the patient's body.) The elbow angle varied between <90º to almost straight (and was increased as the abduction was increased). The transducer remained in contact with the patient for almost the entire examine.
- Left Scanning Shoulder and Arm: The left shoulder was repeatedly flexed to angles of up to 75º, while often also adopting a posture of slight shoulder abduction. The elbow angle varied depending on the reach from 90º upwards. The left hand remained on the keyboard/control panel for the majority of the scan. Therefore this reaching posture was regularly held for extended periods of time with only very slight changes in position (due to the hand searching for various keys).

Figure 10, 11, 12, and 13: The three figures to the left show typical standing scanning postures and the figure to the rights shows a seated scanning posture (i.e. all for abdominal exams).

Additional observations include:

- The awkward postures of reaching and lateral flexion were exaggerated when having to stretch to the opposite side of the patient. When the sonographer performed scans on the patient's right side, the degree of reaching and lateral bending was significantly reduced.
- When using the newer chair to scan the right side of the patient, the sonographers could often use the contoured back rest as an arm support.
- When we observed a worker using the newer machine in Markdale several of these exaggerated reaching and twisting postures were greatly reduced and at times even eliminated thanks to the adjustability of the machine.

Gripping the Transducers:

There were several different transducers, each suited for certain exams and body types and many of the transducers had various handle dimensions The grip the sonographer used on the transducer also varied throughout the exam depending on the position, location and required force. The majority of the time a variation of a pinch grip was used to hold the transducer. During our observations only the right hand was used to scan the patients and each worker we spoke with stated that they only used their right hand to scan. One worker we observed wore a strap around their upper forearm to hold and support the cable of the transducer.

Figure 14, 15, and 16: In the first two figures, the sonographer is using what she described as a typical transducer, and is showing two common pinch grips. The figure to the right shows the some of the variety of transducers that are available for the sonographers to use (i.e, the various sizes and handle shapes).

Required Force for the Transducer:

The amount of force the sonographer needed to apply varied depending on the type of exam and the build of the patient. We asked two sonographers to press against the transducer to imitate the amount of force typically required for a thin build patient, a

normal build patient and also a heavy/obese patient. The table below displays these findings and the figure illustrates how this information was collected.

Table 1: This table displays the amount of pressure two workers applied to the force gauge when they were asked to estimate the amount of force they apply when scanning a patient.

	Thin Build (average force)	**Normal Build** (average force)	**Heavy Build** (average force)
Sonographer #1	20 N	36N	50 N
Sonographer #2	42 N	66N	110 N
average	**31 N**	**51 N**	**80 N**

Figure 17: This figure shows the technique we used to measure/estimate the amount of force applied by the sonographer.

Neonatal Ultrasound:

When performing an ultrasound on an infant, the sonographer needed to stand. The hand and transducer entered the incubator through the cut-out sections. The sonographer would rest their arm slightly on the entry ledge.

Often the babies were fussy and would shift around a fair amount. This made it very difficult for the sonographer to get a clear and accurate image and they were frequently turning their head to check the transducers position while scanning. It was very helpful if there was a free nurse in the area to assist with calming the baby to help keep him/her still.

Figure 18 and 19: In the figures above, the sonographer is performing an ultrasound on a new born baby.

Transporting the Equipment and Patients:
If a procedure was needed to be performed in a clinical area, the sonographer would have to transport the machine. This was raised as a concern by several of the workers and so we measured the amount of force required to initiate the movement, steer the machine and to sustain the movement (i.e. keep it rolling along straight ahead). The table below displays the findings and the figures show the sonographers pushing and pulling the equipment.

Table 2: This table displays the amount of force required to initiate and sustain movement and to also steer the cart on both linoleum and carpet floors

	Force (Newtons)
Initiate movement (on linoleum)	96 to 109 N
Initiate movement (on carpet)	135 to 148 N
Sustain movement (on linoleum)	40 to 55 N
Sustain movement (on carpet)	50 to 75 N
Steer the machine (on linoleum)	120 to 130 N
Steer the machine (on carpet)	140 to 170 N

Figure 20: This figure shows the worker pushing and steering the ultrasound machine.

4.2 Questionnaire

Eight sonographers responded to the questionnaire (n=8), out of a total of 11 sonographers in the district, resulting in a response rate of 73%. The respondents ranged in age from 22 to 62 (mean age of 49), and have worked from 0.2 to 27 years as sonographers (mean length of 19 years). The hours worked per week ranged from 15 to 40 hours, (3 full time and 5 part time (30 to 15 hours per week)). 4 of the respondents worked primarily in the Owen Sound hospital, 3 worked at two sites (one being the Owen Sound site), and one respondent worked off site for the week.

All of the respondents were right handed and 7 of the respondents stated that they scanned only with their right hand (i.e. one respondent did not answer this question).

The average stress level was reported as 6 (ranged from 3 to 8, on a scale of 0 = no stress to 10 = extreme stress), and the average stress reported for the day of the survey was 4 (ranged from 3 to 7, on a scale of 0 to 10).

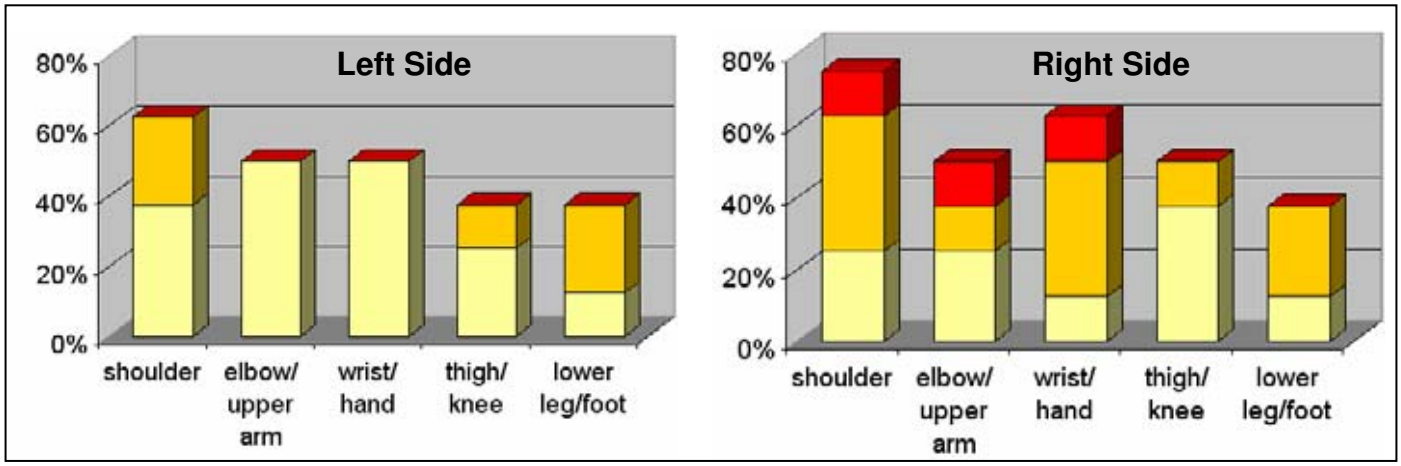


Figure 21 and 22: The figure to the left displays the percent of respondents reporting mild, moderate and severe discomfort on the left side of the body and the figure to the right shows the same for the right side of the body.

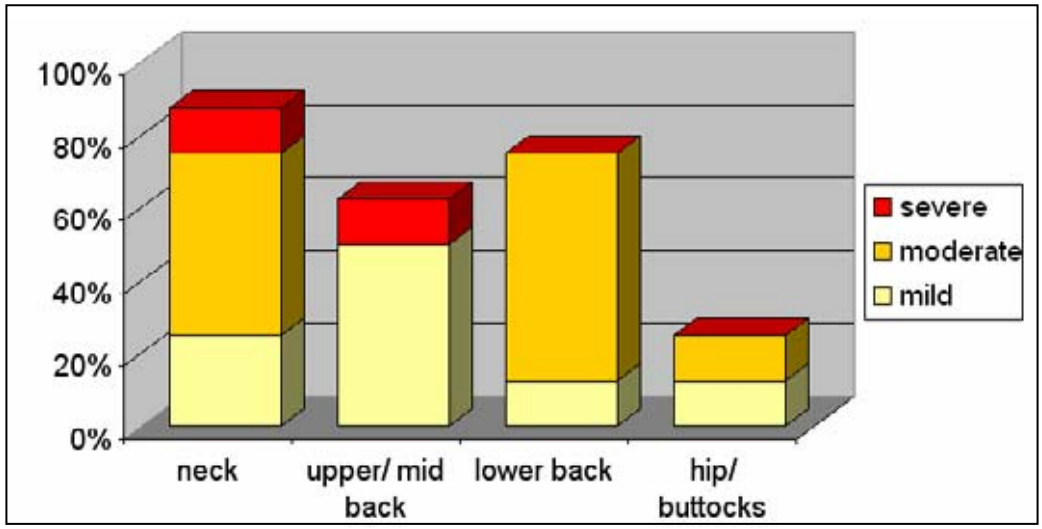


Figure 23: This figure displays the percent of respondents reporting mild, moderate and severe discomfort in the neck, upper/middle back, lower back and hip/buttocks area.

The scans that were reported to give the sonographers the most discomfort were as follows: (i.e. these are listed in order from most reported)

- obstetric
- abdominal (also including abdominal pelvis)
- transvaginal
- carotid doppler
- venous doppler
- musculoskeletal
- thyroid

The patient factors that were reported to contribute to a difficult scan were as follows:

- obese patient (every respondent listed this as the number one factor)
- mobility problems
- uncooperative patient
- gas build up
- patient with an IV and/or catheters

The equipment factors that were reported to contribute to a difficult scan were as follows:

- machine problems (e.g. keyboard set-up, fixed screen location, size of machine, age of machine, rigid set-up)
- portability problems (e.g. heavy to move)
- pushing/moving stretchers
- crowded work area
- set-up of equipment/working area (e.g. reach for towels)
- type of chair
- lack of arm support when scanning

5.0 CONCERNS

A number of surveys and papers have identified several activities as key aggravators and contributors of work-related discomfort among sonographers. These include applying pressure with the transducer; adopting static, awkward postures (e.g. shoulder abduction, neck/trunk twisting); poor equipment design; repetitive twisting; and handling portable equipment. (Murphy et al, 2000, Pike et al, 1997, Wihlidal et al, 1997) This section expands on these concerns to describe the injury risk within the job of the sonographer.

5.1 Scanning the Patients – Focus on the Arm, and Whole Body Postures:

Awkward Reaches:

- We observed numerous sustained reaches where with the worker would hold their arm in an awkward posture of abduction of up to 70º placing a considerable load upon the tissues of the shoulder.
- We observed the workers performing numerous repetitive, forward reaches, requiring shoulder flexion of up to 75º which also places a considerable load upon the tissues of the shoulder.
- "Studies have indicated that the expected time to reach maximum shoulder muscle fatigue decreases with increasing reach. At a 30cm reach, the significant (severe pain) fatigue point has been established as 30 minutes, 20 minutes for a 40cm reach and 7 minutes for a 50cm reach." (Bravo et al, 2005)

Minimal Support for the Scanning Arm:

- There was often minimal arm support available for the scanning hand and arm. Occasionally the workers would use the chairs winged back rest or the patient's body to rest their forearm.

Sustained Neck Flexion:

- The neck was held in a posture of flexion and rotation (slightly to the left) while holding the gaze on their screen and only occasionally the worker would rotate their neck to the right to look at the patient. This awkward posture of static neck flexion was caused by the screen level which was too low because the worker would raise themselves up so that the panel was at approximately their elbow height (more comfortable keying level).

Awkward Whole Body Postures

- Their seated or standing scanning postures were held for prolonged lengths of time (up to 45 minutes for regular examines, sometimes more for special exams). They would also regularly lean slightly to the right to be closer to the patient and adopt a slight posture of twisting.

5.2 Scanning the Patient – Focus on the Transducers:

Awkward, Non Optimal Grip on the Transducer:

- Both power and pinch grips were used when holding the transducers, although we primarily observed various pinch grips for the majority of the

scanning time (90%). A pinch grip places the load on the smaller muscles, therefore creating a localized fatigue on the hand and forearm.
- The workers informed us that although the transducers may not have the ideal grip, the transducers could not be replaced, because of the age of the machines.
- A large study found that discomfort and problems with the transducer design was the best predictor of hand and wrist discomfort. (Magnavita et al, 1999)

High force application needed when scanning (e.g. obese patients):
- When we asked the sonographers to estimate the amount of pressure they needed to apply to the transducer head for an obese patient, their force exertions more than doubled the necessary amount of pressure for a thin patient (increased from 20, 42N to 50 and 110 N respectively).
- In comparing these values to the literature they seemed to fall closely in line. Pressure measured by Habes and Baron, on five sonographers found that the average applied force was 4 pounds (i.e. approximately 25 N) with a range from 2.6 to 4.8 pounds, and to a peak applied force of 8.5. pounds (i.e. approximately 53 N) with a range from 3.5 to 14.6.

Cord of the transducer getting in the way:
- When we observed the sonographers scanning the patients we often saw them pulling on the cord to get it out of the way.

5.3 Ultrasound Machine (e.g. monitor, keyboard/control panel)**:**

Monitor:
- The fixed monitor location was a problem because it forced the worker to adopt awkward neck postures of flexion and rotation, as well as twisting of the torso. This position was often held for an extended period of time and created a static load on the structures of the body.
- The clarity and image quality was not as clear on the older monitors.

Keyboard and Control Panel:
- The fixed keyboard and control panel was a problem because it encouraged static, awkward flexion and slight abduction of the left shoulder/arm. This awkward posture was held throughout the exam.
- The older machines did not have as many shortcut keys or any touch screen options.
- The control panel was very large on the older models and required some exaggerated far reaches, particularly in comparison to the newer model in Markdale.
- The workers could not pull themselves underneath the older units; instead they were forced to adopt awkward straddling postures or were exposed to even further reaches and more exaggerated twists.

Quality of the Machine:
- The Owen Sound unit had one machine which was much older and the workers were unable to use this machine for certain types of scans. This created a difficulty with scheduling the exams.

Number of Machines in Owen Sound:

- In Owen Sound the workers shared all of the stations and were regularly switched from one machine to the next for each of their examinations. A few of the workers stated that this bothered them because they felt they were regularly rearranging and adjusting the equipment to better fit them.

5.4 Exam Bed:

Metal Single Wheel Brakes:

- The individual metal brakes were much more difficult and awkward to release than the plastic brakes with the large section for the foot to hit the release area.

Individual Wheel Braking System:

- The lack of a central locking system meant that the sonographer had to spend time unlocking each wheel individually. Several workers mentioned this as a source of frustration during our visit.

Lack of a Proper Cord Management System:

- The electrical cords on the floor made it very difficult to shift the bed around the space.

Lack of Support Features for the Stability Challenged Individuals:

- The bed was fairly narrow (this was to ensure the sonographer could get close to the patient) but there were no rails or assistive devices in the area to help the patients with stability problems get onto and off of the bed. Instead the sonographers were the ones who helped to support and position the patients as shown in the figure below and this put them at a increased risk of injury (particularly with unfamiliar and unpredictable clients).

Figure 24: This figure shows a sonographer assisting a patient with stability problems onto the exam bed.

5.5 Work Area Organization:

Crowded Work Area:

- Several workers commented both to us and on their questionnaires that their area was crowded and that they did not have enough workspace.

Awkward Twisting and Reaches:

- The sonographer's left hand/arm would reach to awkward levels, to retrieve items such as gel, gloves, towels etc. This was especially evident when the workers would perform these reaches from a seated position as shown in the pictures below.

Figure 25 and 26: The figure to the left shows the worker reaching to retrieve the gel from beside the monitor and the figure to the right shows the sonographer reaching to retrieve the gloves.

5.6 Writing up the Report & Entering the Information into PACS:

Limited Space to Write Comments from the Screen:

- The workers needed to take the results/measurements from the screen and enter them into the report. Unfortunately there was no convenient writing surface close to the screen so the sonographer often settled for the table to the left (which required her to continually step and twist to look at the monitor to retrieve the numbers), or the worker tried to write on the edge/corner of the machine (which was very awkward because of the buttons and controls).

Awkward Computer Set-up:

- Although the typical set-up of the computer on the wooden fixed storage unit is not ideal, the computer is only used for very short periods of time and therefore is not likely a very large concern. One item with the computer that did bother the workers was the location of the scanner, which was located to the left of the monitor and sat upright. This awkward set-up forced the worker to perform an extended reach, often to about shoulder height (i.e. the reach height varied depending on the height of the worker).

Low Lighting Levels for the Paper Work:

- The lighting levels were very low to improve the image quality on the screen but after the exam was complete the sonographer had to take the information from the screen and write it onto a report. Performing writing and reading tasks in very low lighting levels can place a strain on the eyes.



Figure 27, 28, and 29: The figure to the left shows the worker writing on the ledge of the machine, the middle figure shows the worker reaching to the scanner and the final figure shows the worker working on the computer (using the mouse to check the information which was just entered).

5.7 Transporting Equipment:

Transporting the Ultrasound Machine:

- The machine required forceful pushing and pulling exertions to move, steer and to stop the machine. These forces were significant and measured between 40 to 170 N. This machine was also moved over long distances, although the worker would repeatedly have to slow down or stop, and start up again when heading into obstacles and when getting onto and off of the elevator. The Snook tables were used to evaluate the maximum acceptable force for 90% of the female population and it was found that the maximum initial forces were 150 to 190 N and the maximum sustained forces were 60 to 80 N. When comparing the forces that were measured on site (from table 2) to these values, you can see that the workers are exerting close to and in some cases exceeding the recommended maximum level.
- Occasionally the machine also had to be manoeuvred around in a small, cramped work space and this was a very difficult task to perform.
- Several workers commented to us during our visit, and some noted it in their questionnaire, that this was a very difficult and heavy task.
- There were no obvious, easy to use handles on the machine.

Transporting the Stretchers:

- This was described as a difficult task when the workers needed to manoeuvre in and around a small or cramped workspace.
- The stretchers were very long and awkward to move and several workers would choose to pull the stretchers rather than push them because they felt they had more control, although it was a slightly more physically demanding method.

5.8 Performing Scans on Stretchers:

- This type of bed is larger and more difficult to adjust. This often results in exaggerated awkward working postures since the sonographer could not get in as close to the patient or is not afforded the same access and positioning benefits (e.g. the normal exam bed has cut outs and contours).

5.9 Performing Scans in the Neonatal Unit:

Awkward, Static Scanning Posture:

- The sonographer maintained a very awkward posture, with the right arm abducted out to the side reaching into the incubator. The worker had to repeatedly rotate from a flexed position (i.e. looking at the control panel/monitor) and over to the right to observe the baby to ensure the transducer is in the right place.

Contact Stress on the Right Forearm:

- The forearm rested on the entry edge of the incubator creating a contact stress and compressing the soft tissues of the forearm.

Difficult, Active Patients

- The babies can be very active and will therefore move a great deal during the exam making the job of getting a clear image very difficult for the sonographer. Occasionally the worker had to stop the scan to try and settle the baby down, particularly when there was no one else around to assist.

5.10 Workload:

Increased Patient Volume and Scanning Time:

- Before the new PACS system was implemented, the workers performed more additional tasks, some of which required walking and dynamic movements between the exams. This represented "recovery time" for the muscles which had been statically stressed throughout the scanning time.
- Several workers commented that the scanning time has increased over the years and they expect to see this trend continue. One worker stated that "this was both a benefit and a downfall of the new filmless process".
- In 1991 and 1996, Wayne Persutte conducted a survey of 200 sonographers, he found that these workers routinely performed 6 to 10 per day in 1991, and by 1996 this number had jumped to 11-15. (Persutte, 2002)
- A 1999 study which has been previously mentioned found that the average time spent for each examination was related to neck and back pain, as well as hand and wrist discomfort. (Magnavita et al, 1999)

Worker Shortage:

- A few of the workers we spoke with were part time and some said that they were trying to retire. One worker commented that if someone can't work because they are sick, there is often no one to replace them and patients need to be cancelled or reassigned, increasing the workload on the workers present.

5.11 Stocking the Area with Supplies:

Heavy Handling and Awkward Stooping and Reaching Postures:

- The laundry is retrieved in bundles and can weigh up to twenty pounds.
- Often the worker must adopt awkward stooping, squatting, twisting and reaching postures when retrieving the stacks.

Awkward, Forceful One Handed Pinch Grips ("Sandwich" Grip):

- When the laundry is handled in this type of grip it places strain on the hand and forearm muscles (particularly the wrist extensors and finger flexors).

Figure 30 and 31: These figures show the worker retrieving laundry from the cart.

5.12 Retrieving Films:

Heavy Carries and Awkward Handling of Films:

- These loads could be fairly heavy and would often weigh between 20 to 25 lbs. The workers needed to be very careful when handling these items because they can slip easily out of the workers hands (it is very similar to carrying a large deck of cards).

6.0 Recommendations

The recommendations listed in this section were identified and brought to our attention by the workers and/or were referenced from various sources in the literature. These recommendations have been grouped into two main sections, engineering controls (i.e. any physical change in the workstation or equipment design) and administrative controls (i.e. changes in the work scheduling and operations).

Several new initiatives and designs are being worked on by numerous groups and manufacturers around improving the design of the equipment and software available to the sonographers and therefore it is important to keep in contact with your professional groups as well as with reputable manufacturers to ensure that new and improved methods are considered when purchasing equipment.

6.1 Engineering Recommendations:

Chairs:

- Ensure the chairs allow the worker to position themselves in a comfortable, neutral position. All of the workers should be provided with chairs that they feel comfortable and supported in. Since the majority of the workers we spoke with liked the contoured, winged chair, make these available at all of the sites if the workers so desire one. An Italian study focussing on over 2000 sonologists found that "a comfortable chair and correct position of the body protected from the onset of neck and back pain." (Magnavita et al, 1999)

Exam Bed:

- Overall, the exam bed was very well designed and all of the workers we spoke with were pretty happy with it. Only two recommendations for improving the design were suggested.
- Equip the beds with a central, easy to use, locking system.
- Equip the beds or the room with a rail or some type of assistive device to help clients who have a stability problem. Be careful not to interfere with the sonographer's ability to pull them self underneath the bed when these rails are not in use.

Monitor and Control Panel (Ultrasound Machine):

- Ideally the panel should be able to move in all three directions as well as have the ability to tilt and swivel to match the chosen position of the sonographer, all with the use of only one hand. The control panel should be placed in a position that allows the upper arm to relax beside the body and the hand to work at approximately elbow height (therefore there should be minimal reaching and approximately a 90º elbow angle).
- The monitor should also be very adjustable and allow the worker to move it from side to side, up and down, in and out, and angle it properly all with the use of only one hand.
- A second monitor will allow the scanner to have more flexibility and ability to work in a neutral posture. (e.g. this could be mounted beside the patient)

- Touch screen commands and programmable keys help with minimizing the keystrokes and improving the efficiency of the exam.
- Voice activated software can greatly reduce in the amount of keying and control panel work that is needed allowing the sonographer to adopt more natural, comfortable postures. A study examining the benefits of using voice activated software found that the use of such software resulted in a 91% reduction of forward reaches required by the non scanning hand to reach the keyboard. This study also found a reduction in the "average length of time required to perform an examination by 8 minutes, thus reducing the operator's exposure time to injury-producing scanning postures and forces." (Bravo, 2005)
- Update the machines and ensure the monitors are of a high quality so that they provide a clear, crisp image to the sonographer. This will assist the worker in identifying structures and sites more readily and easily (therefore providing a more accurate diagnostic opportunity) but will also help with reducing eye strain.

Alternative transducer design:

- Ideally the ultrasound transducer should be designed to allow the user to use the most comfortable and effective grip. If a very low amount of force is required and the technician is focusing on the precision of probe placement, a pinch grip using multiple fingers is likely the ideal choice. When the technician needs to be able to apply force and pressure with the transducer, the grip should allow the worker to elicit larger muscle groups which can handle higher force loads more effectively, therefore the ideal grip would be some type of power grip or even a modified power grip/palm press. A paper by Kreofsky et al describes/proposes alternative designs for the transducer in an effort to improve the usability and reduce the physical stressors placed upon the sonographer. The ideas proposed in the paper include a two handed probe (two types, the hospital must be equipped with voice activated software for this to be an option), mechanical arm assist (two types), strap design, and a foam transducer. (Kreofsky et al, 2004)
- A wireless transducer will free the sonographer from having to support and work against the restrictive cord, and it will also allow them more freedom and flexibility to move and work in various positions.
- Provide workers with a cable brace to secure the cord to the workers arm. This should reduce the amount of cord pulling and repositioning that is required. One worker we spoke with was already using this brace and she found it very helpful.

Support Cushions:

- Provide support cushions to the sonographers of varying shapes and sizes. This will allow them to work in an awkward reaching posture while taking the load off the abductor and flexor muscles of the shoulder lessening the amount of fatigue and discomfort.

Portability:

- Purchase one ultrasound machine that is ideal for portability, i.e. it is lighter and easier to manoeuvre. The recommendations from the Society of Diagnostic Medical Sonographer Conference (SDMS) state that the machine should not require more than 50lbs of push/pull force to move.
- The units, if being transported, should also be outfitted with comfortable handles to assist in transporting the unit. Ideally these should be height adjustable and be shaped for a power grasp.

Footrests:

- Footrests will assist in placing the worker in a neutral supportive posture. When sitting at higher levels it will allow them to take the pressure off of the back of their legs and when standing it will allow them to vary their position by shifting from one leg to another (e.g. bar rail). During our visit one worker commented that they would like one but they felt that currently the machine was too bulky underneath and the area was fairly cramped.

Floor Cable management:

- A cable management system so that the cords are not being run over by the beds should be considered. Some of the workers had been inventive and held the cables held up with tape to reduce this problem. See the figure below.

Figure 32: This figure shows the cord taped up onto the bed

Personal Stations:

- A few workers stated that they would appreciate having their own station for the day. This was so they can personalize the area to fit them.

Writing Station & Task Light:

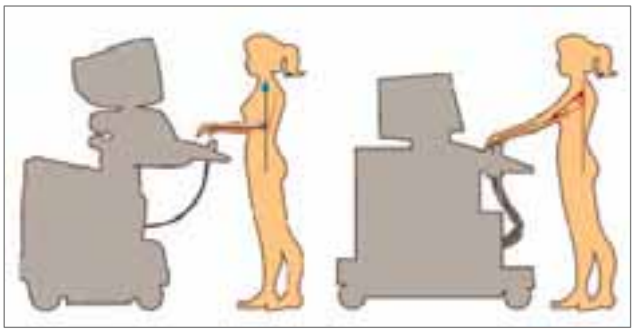
- A writing station would be useful to help the sonographers in taking the measurements from the screen and writing them up onto the paper. One worker we spoke with had the great idea of having a flip up table to sit over the control panel/keyboard.
- A task light would also be helpful to provide necessary light, while keeping it directed onto the paper, and not interfering with the screen clarity, when writing up the report.

Organization of Items:

- When organizing the area, ensure the items which are frequently used are placed within an easy reach of the worker.
- Do not store items such as linens below knee height or above chest/shoulder height.

Summary of Engineering Controls:

It is important to stay up to date on new equipment designs which will help to reduce awkward working postures and improve the overall job design. A surface EMG study on the neck and shoulder regions, by Murphey and Milkowski, 2006 showed the importance of the adoption of neutral working postures when examining two muscle groups. They found a 65% reduction in left upper trapezius muscle activity by changing the scanning postures from 50º of abduction (sideways reach) to a neutral posture (0º of abduction). The right suprascapular fossa showed a reduction in muscle activity of 46% when taking the arm from 75º of abduction to 30º. Also, supporting the forearm while scanning in this 30º abducted posture, resulted in an 88% reduction in muscular effort. (see the figures below for an example)



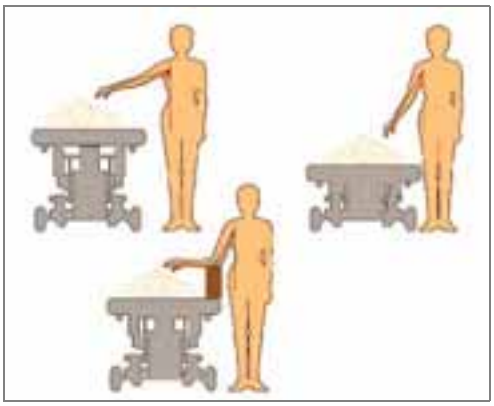


Figure 33 and 34: The figure to the left shows two testing positions for measuring the left upper trapezius (shoulder flexion of 50º and a neutral shoulder posture), and the figure to the right shows the three positions used to measure the muscle activity in the right supraclavicular fossa (abducted at 75º, abducted at 30º, and abducted and supported at 30º). (Murphey, et al, 2006)

An example of how an improvement in equipment design can greatly affect the health and efficiency of the worker is to consider the changes made in Markdale with the newer machine. The one worker we spoke with described the equipment in Markdale as “much easier to use and causes less fatigue/muscle strain than the machines in Owen Sound”. These new features included a very adjustable monitor, control panel/keyboard, and several shortcut keys/touch screen (for commonly used annotations).

6.2 Administrative Controls:

Form an Ergonomics Committee:

- Consider forming an “Ergonomics Committee” in your workplace. The committee’s role is to focus on the ergonomic concerns within the workplace and then take a participatory approach to problem solving. Often this committee reports directly to the joint health and safety committee (JH&SC). (A free booklet is available from OHCOW which outlines how to develop an ergonomics committee. Please contact us to receive a copy)

Worker Involvement:

- When discussing the problems within any work setting, it is always extremely important to get feedback and input from the workers who are performing that task.

Equipment Purchasing:

- Before buying any new equipment, always have the workers try the different types of equipment available to ensure that the best product to meet your facility's needs is being purchased.

Stretching:

- Encourage the workers to perform stretches during down time or schedule breaks to do this. This will encourage blood flow as well as reduce localized fatigue. A research project, which took place in a hospital in Burnaby, British Columbia, designed, implemented and evaluated an exercise program which was designed specifically for echocardiographers. This program involved stretches that were to be performed before, during and after the workers shift. (Christenssen, 2001) It may be beneficial to review this stretching program, with a physiotherapist, and work together to design a similar program which would be appropriate for your sonographer group.

Varying Work Posture and Adopt Neutral Postures:

- For the worker, think of ways to vary your work postures throughout the day so that you are spreading the load out over more tissues and concentrate, whenever possible to position yourself in a neutral, supportive posture while scanning. This will help in reducing localized fatigue and discomfort. This starts with being aware of your working posture every time you scan.
- Avoid retrieving items from awkward locations while seated.
- Many resources recommend that the worker rotate their scanning hand, but when this suggestion was floated to the workers, most did not feel that this was neither practical nor possible. If this suggestion is adopted please be aware that the worker will need a practice period and they will be slower and more awkward at first.

Task Rotation:

- Schedule the work so that the sonographers are not performing two lengthy scans in a row. Also ensure the workers are given sufficient time between scans to complete all of their paper work and perform short stretches to give the muscles groups much needed recovery time.
- Mix other activities between workers such as stocking the work area with necessary supplies and laundry.

Employee Education:

- One of the most effective recommendations is the adoption of an employee education program that addresses issues such as:
    - Injury risk factors (i.e. force, repetition, posture) with job specific examples (e.g. identifying awkward and dangerous scanning postures…),
    - Body mechanic principles (i.e. moment of force) to review safer ways to perform various tasks (e.g. how to place their body in neutral and supporting postures…) and,
    - Injury prevention techniques and principles (e.g. review how to adjust and use all of the available equipment and accessories…)
- Awareness needs to be raised so that the workers are equipped to take partial responsibility for a healthy workplace, by doing such things as taking frequent micro breaks and by adopting more neutral postures when able.

Workload:

- Ensure the workload for the sonographers is kept at a manageable, comfortable level and that they are not rushing through their work. A 2002 paper by Wayne Persutte stated that he felt that a sonographer should be able to perform 8 scans per day (i.e. that this number is based only on his experience) and that this should never exceed an average of 10 patients per day. He stated that although this ideal number will vary between workers, "the goal should be how many examinations can be comfortably performed without undue physical and intellectual stress"(Persutte, 2002).

6.3 General Recommendation:

Use the Literature: Several good quality resources have already been developed to lead the workplace through the process of improving the work set-up, equipment, organization, environment, and work habits, specific to the job of sonographers. Two of these resources have been included in the appendices and they are as follows:

A scanning workstation checklist was developed by Jody Arnold Hancook in 2002 to assist the sonographer and employer in determining if the equipment and the set-up is suitable for the scanner. This checklist has been listed in appendix B. (Hancock, 2003)

The Society of Diagnostic Medical Sonography developed an "Industry Standard for the Prevention of Work-Related Musculoskeletal Disorders in Sonography". This paper has been included in the appendix of this report but is also available to download from the SDMS website. (SDMS, 2003)

7.0 CONCLUSION

The goal of ergonomic interventions is to reduce the incidence and severity of the injuries as well as improve the morale and efficiency of the workers.

The primary musculoskeletal injury risks/concerns which have been outlined in this report include:

- sustained and repetitive awkward postures of the hand/wrist, arms, neck and whole body,
- applying pressure with the transducer,
- poor equipment design, and
- poor portability of the equipment.

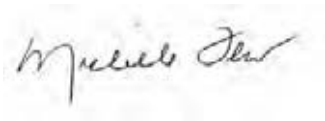
All of the recommendations listed in this report are aimed at improving the job design and reducing the workers' risk of injury. These ideas, as well as the thorough recommendation lists which are included in the two appendices, are meant as a starting point and should be expanded upon and researched thoroughly before implementation. We encourage you to involve the workers in this process since they have a superior understanding of the problems within their jobs, and also some great ideas on improving their job design.

Your workplace has already made a vast improvement in the job design since acquiring the new exam beds (which were designed by a sonographer). Several workers commented on how this change drastically improved their job. Other smaller improvements have also been made as well but it is important to mention that the improvement planning should never stop. Ergonomics is a continual process and the "perfect" and "ideal" design is continually changing.

Several articles have been referenced in this paper. Please contact us if you are having difficulty locating them. We would be happy to send you a copy.

If you have any questions or concerns with this report, please do not hesitate to contact us. We are very interested in coming back to meet with you again to review the findings within this report, brainstorm recommendations, and to help provide a future direction for your project.

Sincerely,



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Appendix A: Work Health Questionnaire

Work Health Questionnaire

1. Which is your dominant hand?	☐ Left	☐ Right
2. What gender are you?	☐ Male	☐ Female

3. How old are you? _____ years

4. How long have you worked for as an ultrasound technologist? _____years

5. How many hours do you work each week? (average) _____hours

6. Which hospital do you work out of? (average)

- _____ hospital for _____days/week
- _____ hospital for _____days/week

7. Which hand do you scan with?	☐ Left	☐ Right	☐ Both

8. Please list top three scans which you find gives you the most discomfort perform.

- _____
- _____
- _____

9. Please list the top three patient factors which contribute to a difficult scan (resulting in discomfort for you).

- _____
- _____
- _____

10. Please list the top three equipment factors which contribute to a difficult scan (resulting in discomfort for you).

- _____
- _____
- _____

Comments:

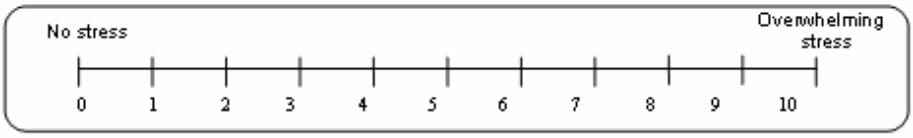
_____

_____

_____

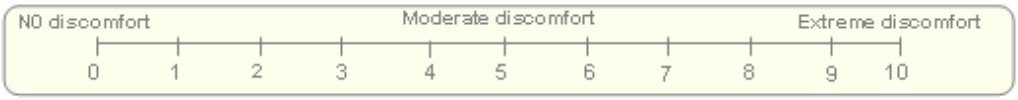
Appendix A: Work Health Questionnaire

11. Using the rating scale shown below, **please circle** the **level of stress** you feel at work **today**.



12. Using the rating scale shown below, **please circle** the **average level of stress** you feel at work **overall.**

13. Using the rating scale shown below, **please enter the level of discomfort that you feel at the end of an average workday,** into the box beside each listed body part.



Appendix B: Scanning Ergonomics Workstation Checklist.
Developed by Jody Arnold Hancock (Hancock, 2003)

SCANNING ERGONOMICS
WORKSTATION CHECKLIST

Check each item on the list that is identified to be in compliance with ergonomic specifications. Provide explanations for those items that do not receive a check, or those that cannot clearly be identified to be in full compliance. Note: Some items may have to be determined through conversations/interviews with the sonographers.

EQUIPMENT CONSIDERATIONS

CHAIR

- ❑ Easily adjustable from a seated position.
- ❑ Height adjusted so users' thighs are parallel or slightly inclined downwards to the floor.
- ❑ If footrest is utilized, it is wide enough for both feet.
- ❑ Backrest height adjusted to fit the small of the users' back and adequately support the spine.
- ❑ Backrest angle adjusted for the user to sit upright while scanning and using control panel.
- ❑ Chair does not impede user from getting close to ultrasound unit control panel (due to chair arms, etc.).
- ❑ Chair swivels, so that the user can easily manipulate both the transducer and the control panel.

ADDITIONAL COMMENTS/SUGGESTIONS: _____
_____
_____

ULTRASOUND UNIT

- ❑ Control panel extends outward, so that user has clear leg room beneath and can get close.
- ❑ The control panel/keyboard height is EASILY adjustable.
- ❑ The control panel/keyboard detaches from the monitor, to ensure a comfortable working position/ angle, without movement of the entire unit.
- ❑ When using the control panel/keyboard, the user's forearm is parallel to the floor or angled slightly downward, with support.
- ❑ The user can easily manipulate the control panel functions without a wide variety of arm motion.
- ❑ When sitting with good posture and looking straight ahead, the user is looking directly at the top edge of the monitor screen.
- ❑ The screen is located at a comfortable reading distance, without notice of the user squinting or leaning to visualize data.
- ❑ The characters on the monitor screen are easily legible.
- ❑ The monitor image is stable.
- ❑ The position of the screen is EASILY adjustable.
- ❑ The contrast and brightness of the monitor are readily adjustable.
- ❑ Glare and reflection from the monitor screen is minimal.
- ❑ The monitor can be positioned at various angles (or an auxiliary monitor is provided), for user comfort and patient interaction considerations, if needed.
- ❑ Transducer heads are large and easy to manipulate with a power grip.
- ❑ Transducer cables are properly supported on the equipment.

ADDITIONAL COMMENTS/SUGGESTIONS:_____
_____

Appendix B: Scanning Ergonomics Workstation Checklist.
Developed by Jody Arnold Hancock (Hancock, 2003)

SCANNING TABLE

- ❑ The scanning table height is EASILY adjustable.
- ❑ When scanning the patient, the user can get close to the patient, so that the elbow is supported, with the forearm parallel to the floor or angled slightly downward.
- ❑ The scanning table has been designed with the user in mind (arm rests, head extension for neck studies, foot rests for transvaginal studies, etc.).

ADDITIONAL COMMENTS/SUGGESTIONS:_____

_____

_____

ANCILLARY EQUIPMENT

- ❑ If form documents must be read, a document holder is provided and is at a level where the documents are legible to the reader.
- ❑ Gel/gel warmers are within accessible reach, without causing excessive reaching or twisting.
- ❑ Sponges or supports are provided and utilized to support the arm, as needed.
- ❑ An adequate writing surface is available, at the appropriate height level, in the event that the sonographer should need to record information.

ADDITIONAL COMMENTS/SUGGESTIONS: _____

_____

OTHER CONSIDERATIONS

PATIENT POSITIONING

- ❑ Active patient positioning and body variances are utilized to minimize reaching, twisting and/or extreme upward wrist angles.
- ❑ The sonographer uses the patient or the table as a support, as necessary.

ADDITIONAL COMMENTS/SUGGESTIONS: _____

_____

SONOGRAPHER DUTIES

- ❑ Variance in tasks.
- ❑ Appropriate rest and stretching between studies.
- ❑ Utilizes "shortcut" key functions on control panel.
- ❑ Uses shoulders to support transducer cable weight, if equipment supports are not available.
- ❑ Stands during a portion of the exam to reduce reaching, or uses an adjustable sit/stand stool.
- ❑ Slightly adjusts weight, on occasion, from one foot to another when performing exams in a standing position.
- ❑ Minimizes awkward postures, turning entire body as needed, to prevent twisting of the back and neck.
- ❑ Keeps arms close to body and shoulder over wrist through the majority of the examination.

Appendix B: Scanning Ergonomics Workstation Checklist.
Developed by Jody Arnold Hancock (Hancock, 2003)

- ❑ Maintains minimum shoulder and wrist angles during the scanning process.
- ❑ Reduces the force of the transducer grip at the level of the fingers during scanning.
- ❑ Additional consideration: Alternates scanning to nondominant hand, if capable.

ADDITIONAL COMMENTS/SUGGESTIONS:_____

ENVIRONMENT

- ❑ Satisfactory background lighting for the ability to read both the screen and documents concurrently.
- ❑ Comfortable room temperature and air flow.
- ❑ Noise level is conducive to concentration (or to duties, such as voice data while recording or listening to Doppler signals).
- ❑ Appropriate staffing within department, to prevent muscular injury by overuse and/or carelessness.
- ❑ Linen and other often-used items have not been placed too high or too low on shelves, to create constant reaching and bending during the day.

ADDITIONAL COMMENTS/SUGGESTIONS:_____

SONOGRAPHER LIFESTYLE

- ❑ Practices proper nutrition.
- ❑ Maintains a consistent exercise program, specifically utilizing strength building techniques.
- ❑ Assures adequate rest is received.
- ❑ Is involved in stress-relieving activities (e.g. enjoyable hobbies).

ADDITIONAL COMMENTS/SUGGESTIONS:_____