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Indian Health Service Dental Clinics
Arizona

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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Highlights of the NIOSH Health Hazard Evaluation

Indian Health Service Dental Clinics

Employees and the Indian Health Service (IHS) management were concerned about musculoskeletal disorders, particularly neck injuries, among the staff of the IHS and wanted to know the extent of the problem and what equipment and tasks were associated with these disorders.

What NIOSH Did

- # We took photographs and videotapes of the workers doing their jobs. We also made measurements of the work area and equipment.
- # We interviewed 39 employees and asked them to fill out a survey. The survey asked about work practices, hobbies, and musculoskeletal disorders of the back, shoulder, neck, elbow and hand/wrist.

What NIOSH Found

- # Forty eight percent of workers had work-related (WR) neck disorders, 42% had WR back disorders, and 37% had WR shoulder disorders.
- # Dental assistants had a significantly greater prevalence of WR neck musculoskeletal disorders than dentists.
- # The most significant work risk factors for dentists were static loading of the neck (prolonged focus on small areas inside the patient's oral cavity) and static loading and awkward postures of the hands (anesthetic injection and drilling of patient's teeth).

- # The most significant work risk factors for dental assistants was twisting and turning of the back, and extended reaches of the arms to access dental instruments, prolonged static postures, forceful exertions of the hands while using dental instruments, and carving fillings.

What Managers Can Do

- # Replace older rear delivery equipment with more modern "continental-style" over-the-patient equipment. Utilize patient chairs that are as thin as possible.
- # Ensure that existing equipment is functioning properly and that all chairs are able to be raised and lowered within the range for which they were designed.
- # Design operatories so that the assistant or dentist does not have to get up or twist to use an amalgamator or curing light.

What Employees Can Do

- # Practice good posture while treating dental patients.
- # Utilize slow set amalgams when doing large fillings.



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**Health Hazard Evaluation Report 98-0032-2795
Indian Health Service Dental Clinics
Arizona
June 2000**

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SUMMARY

On November 12, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from the management of the Dental Services Branch of the Indian Health Service (IHS) to evaluate work-related musculoskeletal disorders (WRMDs), particularly neck disorders. These managers were concerned that older rear delivery equipment, used by the Branch, was contributing to an increase of WRMDs among employees of the dental clinics.

To assess job tasks, the manner in which dental equipment was used, and the WRMDs among the dental personnel, site visits were conducted at 3 IHS clinics on February 9-11, 1998, and 3 more on November 2-7, 1998, by a NIOSH ergonomist and epidemiologist. The ergonomic evaluation included videotaping of tasks, still photographs and observations of job tasks of dentists and dental assistants. The medical evaluation consisted of interviews with employees and a self-administered questionnaire. The questionnaire dealt with work practices, hobbies, and back and upper extremity musculoskeletal problems.

The ergonomic evaluation showed that the most significant work risk factors for dentists was static loading of the neck (prolonged focus on small areas inside the patient's oral cavity) and static loading and awkward postures of the hands (anesthetic injection and drilling of patient's teeth) while performing dental tasks. The most significant work risk factors for dental assistants was twisting and turning of the back, and extended reaches of the arms to access dental instruments from the dental trays, which were located behind the patient in 5 of 6 sites. In addition, dental assistants were at risk for hand and wrist disorders possibly from prolonged static postures, forceful exertions of the hands while using dental instruments, and from carving fillings.

All employees present on the day of the site visit were eligible for participation in the study and 47 dental workers completed the questionnaire including: 3 at the Colorado River Indian Tribes [CRIT], 11 at the White Mountain Apache Tribes [WMAT], and 6 at the San Carlos Service Unit [SCSU] during the first site visit of February 9-11, 1998, and 11 at Crownpoint, New Mexico, 4 at Winslow, Arizona, and 12 at Tuba City, Arizona during the second site visit of November 3-5, 1998. For our analysis, an upper extremity musculoskeletal disorder was considered to be related to the workplace (WRMD) if this disorder (pain, numbness, tingling, aching, stiffness, or burning in the affected part) occurred within the preceding year and all of the following applied:

- (1) musculoskeletal disorders began after starting the current job
- (2) musculoskeletal disorders lasted for more than one week or occurred at least once a month within the past year
- (3) musculoskeletal disorders were reported as "moderate" (the midpoint) or worse on a five point intensity scale.

The prevalence of WRMDs was 48% (21 out of 44 workers) for the neck, 42% (18 of 43) workers for the back and 37% (16 of 43 workers) for the shoulder. Non-dentists had a significantly greater prevalence of

work-related [WR] neck musculoskeletal disorders than dentists; nineteen of 30 non-dentists, which included assistants and hygienists, reported WR neck musculoskeletal disorders (63%) while only one of 12 (8%) dentists reported WR neck musculoskeletal disorders (OR 19.0, 95% CI 2.1-859.1). Non-dentists also had a greater prevalence of WR hand/wrist disorders than dentists. Forty-two percent of non-dentists and no dentists reported hand/wrist WRMDs ($p=0.007$, OR undefined). Workers in the older clinics reported more musculoskeletal disorders than workers in the newer clinics, with the exception of WR back pain where the prevalence was the same in both groups.

On the basis of this evaluation, NIOSH investigators concluded that being a dental assistant with the Indian Health Service is associated with a higher prevalence of work-related musculoskeletal disorders than being a dentist. This work-related injury was associated with older clinics, not being a dentist, hand scaling, and malfunctioning dental equipment. Changes that the Indian Health Service should make to prevent and control these disorders are given in the Recommendations section.

KEYWORDS: SIC 8021 (offices and clinics of dentists) Dentists, ergonomics, dental equipment, neck injuries

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INTRODUCTION

On November 6, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the management of the Dental Branch of the Indian Health Service (IHS). Management was concerned about musculoskeletal injuries, particularly neck injuries, among the staff of the IHS and wanted to know the extent of the problem and what equipment and tasks were associated with this disorder.

Two site visits were made by NIOSH investigators to clinics that were selected by the IHS management, including the Colorado River Indian Tribes (CRIT), White Mountain Apache tribes (WMAT), and the San Carlos (Apache) Service Unit (SCSU) in February 1998. Clinics serving the Navajo tribe, including facilities at Crownpoint, Winslow, and Tuba City, were evaluated in November 1998.

BACKGROUND

The IHS is a component of the Department of Health and Human Services and the Dental Branch is charged with dental health care delivery to Native Americans. It employs both civil servants and officers of the United States Public Health Service. The IHS operates over 300 dental clinics staffed by approximately 800 employees including dental assistants, dental hygienists, and dentists. Some dental clinics are administered by the local tribe. They receive a grant from the federal government, and can either hire their own personnel or contract with the IHS. At the sites visited by NIOSH, all employees were IHS employees.

At the time of the evaluation, the IHS used predominantly rear delivery equipment, which means that the dental handpieces are either located on a cart or are mounted in back of the patient and behind the dentist. Because of these delivery systems, flexion, leaning and rotation may be necessary to select the proper handpiece. It was also necessary for the dentist to move his/her eyes from the well-lit operating field to select a handpiece since the handpieces were not readily accessible to the assistant. The assistant usually sat on the patient's left side and a right-handed dentist usually sat on the patient's right. The position is reversed if the dentist is left-handed. The majority of the rear delivery

equipment appeared to be approximately 15 years old, and this equipment was observed to be in various states of repair, and some equipment could not be easily moved by the dentist or assistant to a more convenient position. Some dentists' or assistants' chairs were not operating properly and, in one case, it was impossible to lower the assistant's chair to the proper working level.

The IHS employs expanded duty dental assistants who, besides traditional dental assisting, scale teeth and place amalgams, including CPAs (cusp protective amalgams). CPAs are amalgam fillings that replace a cusp of the tooth and extend on to the biting surface. These are very large amalgams and are not frequently done in a private practice. They are very time consuming in their placement and require substantial amounts of carving. This carving must be done quickly, before the amalgam gets hard.

The arrangement of the equipment can affect efficiency and whether the operator works alone or with assistants. Medications, linings, cements, amalgam and plastic fillings, impression trays and materials, instruments, and other essentials should be arranged in such a way that the operating team does not have to leave the seated position at the chair to retrieve them.¹ This was not the case at the IHS, and NIOSH investigators observed the dentist or assistant having to get up to mix amalgam.

METHODS

Medical Evaluation

The medical evaluation consisted of confidential employee interviews and the completion of a questionnaire by employees. Every employee present at work the day of the evaluation was invited to participate in the evaluation. Interview questions were similar to those asked on the questionnaire and concerned job duties, whether any musculoskeletal disorders had occurred at work and if any medical treatment was given. The questionnaire dealt with work practices, hobbies, and back and upper extremity musculoskeletal (shoulder, neck, hand/wrist, and elbow) disorders. The questionnaire given on the two visits was similar, particularly with regard to musculoskeletal disorders, and the questionnaire results were combined for analysis where possible.

Analysis of the questionnaire was done using SAS Version 6.12 and Epi Info Version 6 to identify non-work-related and work-related risk factors for each WRMD. Kendall Tau β correlation coefficients were generated for all dichotomous variables and Pierson correlation coefficients were generated for continuous variables. Prevalence rates of musculoskeletal disorders and WRMDs were determined for all studied body areas. The work-related prevalences were determined by dividing the number of people who answered all questions needed to determine if a symptom was work-related by the total number of respondents answering the question concerning the environmental or demographic condition under study. Thus for each studied disorder, workers who did not completely answer a question or left the question blank, were considered, for the analysis, to be missing for that disorder. For continuous variables such as age, height, weight, the number of years in dentistry, and the number of extractions done per week, the median level was determined and prevalence rates of musculoskeletal disorders were compared for workers above and below the median.

Odds ratios (OR) and 95% confidence intervals (CI) were used to measure the association between a disease and an exposure. When the OR is 1 or less, we say that people with the exposure are no more likely to have the disease than people without the exposure. When the OR is greater than 1, we say that people with the exposure are more likely to have the disease than people without the exposure. We also calculated the 95% confidence interval (CI) for the OR. A CI that does not include the number 1 means that the evidence of an association between a disease and an exposure is unlikely to have occurred by chance. Statistical associations were determined using chi-square analyses and, if the people in the analysis were few (less than 5 participants in a cell), Fisher's exact tests. "T" tests were performed and "p" values were computed to statistically analyze group means. By custom, a "p" value that is less than 0.05 is said to be statistically significant and indicates that the observed differences in group means is likely to represent an actual difference.

For each body part (hand/wrist, neck, shoulder, back, elbow) a WRMD was considered present if any symptom (pain, numbness, tingling, aching, stiffness, or burning) in the affected part occurred within the preceding year and all of the following applied:

- (1) Musculoskeletal disorders began after starting the current job
- (2) Musculoskeletal disorders lasted for more than one week or occurred at least once a month within the past year
- (3) Musculoskeletal disorders were reported as "moderate" (the midpoint) or worse on a five-point intensity scale.²

Responses to the questions related to operatory layout comfort and operatory layout efficiency were dichotomized; "good" and "excellent" were considered positive responses, and "fair" or "poor" were considered negative responses. In addition, the continuous variables for hours spent using a home computer or doing a hobby activity were also dichotomized to classify each response as above or below the mean number of hours for all respondents. The dichotomized variables were analyzed using a chi square test and generating a "p" value.

Additionally, a comparison of work risk factors based on the old versus the new clinic design was undertaken. Of the 6 facilities evaluated, four (CRIT, White River Apache, San Carlos and Tuba City) were considered to be older in design (i.e., pre 1985) and two (Winslow and Crown Point) were considered newer. The two newer clinics had either over-the-patient delivery systems or more modern rear delivery systems; the other 4 only had older rear delivery systems. Although each of the older service units was laid out slightly differently, there were many similarities in dental equipment (predominantly rear delivery units), job duties, and cabinetry. For this reason, prevalence of musculoskeletal disorders will be reported for two newer clinics and four older clinics, each as a group.

Ergonomic Evaluation

The ergonomics evaluation coincided with the medical evaluation with site visits to the six Indian Health Service dental clinics mentioned earlier. The ergonomic evaluation consisted of informal interviews with dentists and dental assistants from each facility about work-related musculoskeletal risk factors, measurements of selected dental workstation layouts, and digital pictures and videotapes of dentists and dental assistants performing dental operations on patients.

The videotapes of dentists and dental assistants performing their jobs were analyzed at normal speed and stop action to identify work risk factors. The work risk factors identified *a priori* were: repetition, force, posture, static loading, segmental vibration, and recovery time. The focus of the job analysis was on the upper extremities for both dentists and dental assistants. Work risk factors from the 4 older IHS clinics were compared to those of the 2 new IHS dental clinics described earlier.

EVALUATION CRITERIA

WRMDs in the service industry are common today, and their occurrence continues to proliferate globally. Statistics from 1995 (the latest available data at this writing) showed that "sprains" and "strains" accounted for 49.7% of all occupational injuries in service industries in the United States. Out of all musculoskeletal injuries, 2.1% were related to the neck, 31.4% were of the upper limbs, and 31.4% were of the back.

A number of studies have estimated the prevalence of WRMDs in dental work.^{3,4,5,6,7} Most of the studies are cross-sectional like the one here, providing prevalence rates; because these studies lack comparisons with control groups and do not account for the temporal pattern of events, they are therefore unable to demonstrate true cause and effect.

Neck and shoulder musculoskeletal disorders among dentists, dental hygienists, and dental assistants have been commonly reported by several researchers.^{8,9,10} Pain and discomfort are the major symptoms of neck and shoulder complaints. One case control study found that a group of 99 dentists had a higher frequency of cervical symptoms than a group of 100 pharmacists (44% versus 26%; Relative risk [RR] = 2.1; 95% CI 1.4, 3.1).¹¹ Female dentists reported neck musculoskeletal disorders 1.4 times more often than male dentists (95% CI 1.0, 2.0). Among the female dentists, the frequency of musculoskeletal disorders increased with age (not observed in male dentists or in either gender among pharmacists).

Risk Factors for Neck and Shoulder Disorders

A comprehensive review of published studies found that repetitive neck movements and continuous arm and hand movements affecting the neck and shoulder demonstrate significant associations with neck musculoskeletal disorders. Researchers have found a strong relationship between neck musculoskeletal disorders and high levels of static contraction, prolonged static loads, and extreme working postures involving neck and shoulder muscles.¹² There was, however, insufficient evidence for positive association between force and shoulder musculoskeletal disorders.

Despite the variety of seating positions for dental personnel, dentists and dental assistants are required to adopt non-neutral postures for much of the workday. The postures adopted usually require prolonged static contraction of the trunk and scapulothoracic and scapulohumeral musculature, combined with repetitive contraction of muscles in the wrist, hand, and fingers during fine hand motor control work. Dental workers usually assume these awkward postures for several reasons:

- to coordinate their positions relative to assistants, with whom they often share limited space;
- to obtain optimal view of teeth within the patient's mouth, often while maintaining a seated posture;
- to provide a comfortable position for the patient; and,
- to maneuver complex equipment and reach for instruments.

Operating positions are usually identified in relation to a 12-hour clock face, and those identified in the current study include:

1. the 8 o'clock position, to the front of the patient's right side;
2. the 9 o'clock position, at the side of the patient;
3. the 10 o'clock position;
4. the 11 o'clock position;
5. the 12 o'clock position, in back of the patient
6. the 1-4 o'clock position on the patient's left side.

The posture and biomechanics of dental workers have been analyzed by several authors. Dentists were found to most commonly use a combination of the flexed and right side-flexion position of the neck with a head-down position (45 to 90 degrees cervical flexion) for 58% to 83% of the studied period.^{13,14}

Significant muscular fatigue can occur within 2 hours in this position.¹⁵ In support of the inference that awkward postures can lead to musculoskeletal disorders, Rundcrantz et al. found that dentists with cervico-brachial disorders adopted a posture of cervical flexion or rotation, or a combination of the two, more frequently than dentists without musculoskeletal disorders ($P < .01$).⁸ A study by Davies and Eccles¹⁶ showed that patients tend to prefer being in the 30-degree cervical flexion position while the operator prefers the patient to be in a nearly horizontal position of 15 degrees for clearer viewing without neck flexion. Eccles and Davies carried out postural studies using a phantom head and each operator was asked to carry out a cavity preparation on six standard teeth—both upper first molar teeth, both lower second molar teeth, and labial cervical cavities in the upper left canine and lower right canine. They recommended that the operator work in a 9 o'clock or 12 o'clock position relative to the patient. They also found that it was better to have the chair in the horizontal position than at 30 degrees to achieve a posture of less stress for the dentist. In general the patient's head should face forwards and not be rotated, except for certain tooth cavities (for example cavities facing the cheek).¹⁶ From this study, a list of requirements for the design of dental chairs was derived, pertaining to adjustability of the seat pan and backrest.

There are several risk factors associated with neck and shoulder disorders and dental work. Prolonged static neck flexion and shoulder abduction or flexion, lack of upper-extremity support, and inadequate work breaks can be major risk factors for neck and shoulder musculoskeletal disorders. Psychological stress may also increase tension in the neck and upper extremity musculature, possibly leading to overall musculoskeletal strain of this body region. Epidemiologic studies reviewed by NIOSH showed a positive relationship between repetition and shoulder and neck musculoskeletal disorders. No specific studies in dentistry have examined the effects of repetitive movement on neck or shoulder problems.¹²

Wrist and Hand Disorders

In addition to neck and shoulder problems, dental work has been associated with hand and wrist problems including carpal tunnel syndrome. Carpal

tunnel syndrome is defined as symptomatic compression of the median nerve within the carpal tunnel, which is the space between the transverse carpal ligament on the palmar aspect of the wrist and the carpal bones on the dorsal aspect of the wrist.¹⁷ Swelling of the tendon sheaths for example, can reduce the size of the tunnel, compressing its other contents. Symptoms of carpal tunnel compression can appear from any activity causing prolonged increased (passive or active) pressure in the carpal canal. Liss et al.¹⁸ used a standardized questionnaire to measure the prevalence of musculoskeletal complaints in 2,142 dental hygienists and 305 dental assistants. They found that after adjusting for age, dental hygienists were 5.2 times (95% CI 0.9, 3.2) more likely to have been told that they had carpal tunnel syndrome and 3.7 times more likely to meet a case definition of carpal tunnel syndrome than were dental assistants. However, these diagnoses were not confirmed by objective tests. Osborn et al.¹⁹ used a questionnaire to survey 444 Minnesota dental hygienists. The results showed that 7% had been previously diagnosed with carpal tunnel syndrome and that 63% of the sample reported one or more symptoms of carpal tunnel syndrome.

There is evidence of an association between carpal tunnel syndrome and highly repetitive work, alone or in combination with other factors. Evidence also indicates an association between forceful work and carpal tunnel syndrome.¹² The amount and type of repetitive movement performed during dental work has not been accurately quantified by previous studies. Liss et al. highlighted that one of the predictors for high prevalence of carpal tunnel syndrome among dental hygienists was a long clinical period of repetitive movements when work was done on parts of the mouth that were difficult to access.⁷ They also presented the predictors of wrist/hand disorders that had occurred in the past 12 months. The duration of work, the percentage of time that the trunk was in a rotated position relative to the lower body when operating, and instrument types were found to be predictors of WRMDs. The impact of instrument type was less clear than that of other predictors possibly because of a greater mix of instruments and longer clinical periods of repetitive movements when work was done on patients with inaccessible calculus.

Because of the high precision required by much dental work, the muscles used in sustaining such

activity are at risk of becoming fatigued and causing discomfort. Stability maintained through static muscle loading in the shoulder and elbow areas for prolonged periods can lead to fatigue and discomfort. Grandjean suggested that with prolonged contraction of upper trapezium (a neck muscle) during upper extremity stabilization, adjacent blood vessels and nerves may be compressed, making the upper extremity susceptible to temporary ischemia (loss of blood flow).²⁰

Low Back Pain

Low-back discomfort is a problem associated with dental work in numerous studies.^{21,22,23,24,25,26,27}

Changes in operating methods in dentistry, which have occurred since the late 1950s, have altered the occupation from a standing to a sitting profession. Shugars et al. found that good (neutral) posture correlated negatively with back pain and, generally, dentists who sat 80% to 100% of the day reported more frequent lower-back pain.²⁵ Static work in the sitting posture requiring spinal flexion and rotation has been associated with increased risk of low back pain.^{26,28,29,30} According to Visser and Straker, since the introduction of the sitting posture, lower-extremity problems of the worker have decreased, but musculoskeletal injuries of upper extremities and the low back have not been eliminated. Loads on soft-tissue structures of the lumbar spine and discs are increased by sitting. Additionally, extensor muscle activity in the lumbar spine area in the unsupported sitting posture is greater than in standing. Discomfort experienced by dental workers was shown to increase over the working day.²⁶

Psychosocial Factors and WRMDs in Dentistry

Studies of psychosocial stress levels experienced by dentists are numerous.^{31,32,33,34} Stressors that have been identified include the psychologic demands of doing meticulous surgery with little or no rest or diversion and time pressures.

Dentists with musculoskeletal disorders showed a significant tendency to be more dissatisfied at work and to be more burdened by anxiety, experiencing poorer psychosomatic health and feeling less confident with their future.³⁵ Lehto et al.²² found that dentists who perceived dentistry as physically too

heavy had a greater 1-year prevalence of neck and shoulder pain (odds ratio (OR) 4.0, 95% CI 1.3,12.2) and low back pain (OR 5.4, 95% CI 1.7,17.2) than those who perceived dentistry as physically light or optimal. Dentists who perceived dentistry as mentally too straining had a greater 1-year prevalence of neck, shoulder pain (OR 2.5, 95% CI 0.9,0.2), and low back pain (OR 4.6, 95% CI 1.5,14.2) than those who did not. Dentists who perceived their work as fast paced had a greater 1-year prevalence of neck and shoulder pain (OR 6.8, 95% CI 1.5, 30.1) and low back pain (OR 3.4, 95% CI 0.8,13.81) than those who did not perceive dentistry as fast paced.

Ergonomics requires understanding of both the physical and the psychological aspects of the workplace. From the review of literature, it is evident that ergonomics plays a significant role in the health of dental professionals, but only after the dentist has recognized and integrated both physical and psychological systems. The musculoskeletal and stress-related disorders associated with dentistry seem to be interrelated. Literature about work-related musculoskeletal disorders and psychosocial disorders associated with dentistry is plentiful. However, ergonomic solutions for dental practitioners are under-reported in the literature. Furthermore, the few ergonomic solutions that have been provided have not been adequately evaluated or validated.

The Availability and Effectiveness of Current Ergonomic Interventions

The modern dentist works seated on a low stool, and the assistant, also seated, provides continuous chairside assistance; this is commonly called four-handed low-seated dentistry. Instruments and equipment are placed within close reach of the dentist and the assistant. The patterns of floor area design have evolved on an empirical basis for each functional area and for flow in occupants' movements. According to Pollack³⁶ the aim of ergonomic intervention should be to achieve optimum access, visibility, comfort, and control at all times of treatment. Many ergonomists have urged an evaluation of the dental workspace and process to improve not only health, but also productivity.

Workplace Layout

Kwasman et al.³⁷ found that the high-speed hand piece transfers were faster and more frequent in the 12 o'clock location when carried out by an assistant. The dentist was able to make the transfer without moving his/her body or refocusing his eyes from the mouth to the unit. However, the passing of three-way syringes was less efficient in the 12 o'clock position by an assistant, compared to the 8 o'clock position without use of an assistant. In the transfer of the three-way syringe, additional time was required by the dentist and the dental assistant using the 12 o'clock position. Hand positions of the dentist and dental assistants needed to be changed from a pen to a palm grasp and vice versa. If the dentist was positioned in the 8 o'clock position, directly picking up the instrument with a palmar grasp increased efficiency.

RESULTS

Medical Evaluation

Interview

Sixty-nine employees worked at the dental clinics that were evaluated. All employees present at work on the days of the NIOSH site visit were told of the NIOSH visit and that the NIOSH medical officer was available if they wanted to be interviewed. A total of 39 workers (57%) were interviewed; sixteen workers were interviewed during the site visit in February 1998 and twenty three during the site visit of November 1998. The employee interviews revealed numerous musculoskeletal disorders including: back problems (12 workers), neck pain (14 workers), hand problems including reported carpal tunnel syndrome (9 workers), and arm/shoulder problems (8 workers); 8 employees reported no musculoskeletal disorders on interview. Two workers reported that they required neck surgery. Five workers volunteered that they would prefer over-the-patient delivery systems. The employees proposed etiologies for their WRMDs that included: having to lean over, twisting and turning when working, CPAs, and having difficulty properly positioning the patient.

Questionnaire

Forty-seven dental workers (68%) completed the questionnaire including: 3 at the CRIT, 11 at the WMAT, and 6 at the SCSU during the February site visit, and 11 at Crownpoint, 4 at Winslow, and 12 at Tuba City during the November site visit. Thirteen (28%) of the people filling out the questionnaire were dentists, 22 (47%) were assistants, 8 (17%) were expanded function dental assistants, and 4 (9%) listed their occupation as lab technician or "other" (front desk worker). Twelve participants were males and 35 were females. Median height of the respondents was approximately 5'3" (range 4'11"-6'3") and the median weight was approximately 170 pounds (range 110-270). The mean age of responding employees was approximately 37 years (range 24-52). Participants had worked at dentistry an average of 12.3 years and had worked at their present location an average of 8.5 years.

Thirty-two participants (71%) reported that they were Native American and 11 (24%) reported that they were white; there was one black and one Asian participant (4%). All dental assistants, but no dentists, were Native Americans. Women were more likely than men to have worked longer in dentistry (mean number of years for men 8.6, mean number of years for women 13.1, $p=0.09$). Women were more likely to have worked at the same location (mean number of years for men 3.3, mean number of years for woman 10.2, $p<0.001$). All dental assistants were women (30 workers), but only 2 of 13 dentists were women ($p<0.0001$). Table 1 shows the frequency of personal and work-related characteristics of survey respondents.

Prevalence of various musculoskeletal disorders in different body areas are presented in Tables 2 and 3. The total prevalence of WRMDs, those musculoskeletal disorders that are not classified as work-related, and WRMDs by clinic type, gender and occupation are given in Table 2. Total musculoskeletal disorders are, in all cases, greater than those disorders that are considered to be work-related. Non-dentists, females and persons working in older clinics generally were more likely to have a WRMD, although the differences were not always statistically significant. Height, weight, or the years spent in dentistry were not statistically significant for any studied WRMD. Age was related only to neck disorders, and being a female was related to neck and hand/wrist disorder. (Table 3)

Non-dentists were more likely to report neck discomfort. Nineteen of 30 non-dentists (63%) reported work-related neck disorders while only one of 12 (8%) dentists reported a neck disorder. This higher prevalence rate of neck pain among non-dentists was statistically significant (OR 19.0, 95% CI 2.1, 859.1). Twelve of 28 non-dentists reported hand/wrist pain while no dentists reported hand wrist pain. ($p=0.005$). There was no statistically significant difference in prevalence rates between dentists and non-dentists for any other symptom.

Dental workers extracting less than the median number of extractions per week (10 extractions) were more likely to report WR neck disorders than those doing more than 10 extractions per week (OR 5.0, 95% CI 1.3, 18.4). Extracting fewer than 10 teeth per week was associated with an increased risk of back WRMD (OR 3.9, 95% CI 1.1, 14.4). Doing hand scaling was also statistically significantly related to the development of WR hand/wrist disorders and 69% of workers who hand scaled reported WR hand disorders as compared with 31% of those who did not (OR 5.0, 95% CI 1.10-27.41). Hand scaling was also negatively correlated with the number of extractions done per week $r = -0.38$, $p = 0.02$).

WRMDs in any studied body area were not statistically significantly related to the dental personnel's position in relation to the patient (6, 9, 10, 11 or 12 o'clock positions), the number of hours spent on hobbies or with computers, the number of patients seen in a day and using a mirror "always" or "usually" as part of one's work. Questions about cusp protective amalgams (CPAs) were asked during the second site visit. These amalgams were done by 19 of the 27 study participants during that site visit. Doing CPAs was not related to the development of any one symptom.

Musculoskeletal disorders and the New Clinics

Workers in the new clinics of the IHS reported less musculoskeletal disorders and improved comfort and efficiency when compared to workers in the old clinics. Workers in the older clinics reported more hand/wrist disorders than workers in the new clinics ($p=0.07$). Workers in the new clinics were also more likely to report that workplace efficiency or comfort was "good or excellent" (as opposed to poor or fair) when compared to workers in the older clinics,

although the differences were not statistically significant. Ten workers (68%) in the new clinics for the Navajo area reported that the operatory efficiency in those clinics was good or excellent, compared with only two workers (22%) in the old clinic (OR 0.14, 95% CI 0.01-1.2). Six workers (40%) in the new clinics stated that the operatory comfort was good or excellent as opposed to three workers (27%) in the old clinics. (OR 0.6, 95% CI 0.07-3.9). There was no relationship between dichotomized reported comfort or dichotomized reported layout efficiency and any WRMD.

Ergonomics Evaluation

Table 4 shows the results of dentist and dental assistant exposure times to potential musculoskeletal risk factors while performing dentistry on patients. Ergonomic evaluation of the 14 dental surgeries videotaped during this study showed the average time a patient spent in the dental chair was 36.6 minutes, the average time the dentist spent with the patient was 16.4 minutes (45% of total time patient spent in the chair), and the average time the dental assistant spent with the patient was 24.4 minutes (67% of total time the patient spent in the chair). On average, dental assistants spent 22% more time performing dental work on patients compared to dentists. The remaining time spent by dentists was performing work on other patients (the ratio of dentists to dental assistants is approximately 1 dentist for every 3 dental assistants/hygienists), filling out paper work, and communicating with dental staff about patient logistics. Because prolonged static loading and awkward posture are the major risk factors for musculoskeletal injury, it is beneficial for the dentist to spend less time with one patient and take short breaks by moving on and seeing other patients. However, the dental assistant remains with one patient longer than the dentist and as a result spends more time in prolonged static loading and awkward posture. With the mini-breaks dentists take between patients and other duties, their prolonged exposure to risk factors are less than the dental assistants, who do not have the mini-breaks to allow for recovery. The dental assistants spent the remaining time cleaning up the operatory following an operation, and setting up another operatory for a pending dental operation. Comparison between old versus new clinics showed that patients in old clinics spent slightly more time in their chairs (39.4 minutes) compared to the new clinics

(35.3 minutes), the dentists spent less time with patients in the old clinics (16.1 minutes) compared to those in new clinics (18.7 minutes), and the dental assistants spent slightly more time with the patients in the old clinics (28.6 minutes) versus the new clinics (21.2 minutes). However, the differences were not statistically significant.

Tables 4 and 5 show the qualitative comparisons of musculoskeletal risk factors between the 6 IHS dental clinics. These risk factors include static loading, awkward postures, high forces to the hands, and repetition. Specific information about activities which could cause, aggravate and precipitate musculoskeletal disorders at each clinic is shown in Appendix A. Generally, the older clinics did not have adequate workspace for the dentist and dental assistants to work comfortably. The primary reason was the limited space between the behind-the-patient dental delivery systems and the patient's head when the chair was fully reclined (less than 20" in most cases). The limited space may have constrained the working postures of the dentists and dental assistants for certain operations (Figures 1 and 2).

Figures 1 and 2 also show dental personnel with a behind-the-patient delivery system that is located on top of a non-adjustable cabinet counter. The dental assistant keeps her lower body toward the dental instruments while she twists her upper body to the left to assist the dentist. This posture was commonly seen for the behind-the-patient dental systems seen in older IHS clinics. Figures 3 and 4 show an over-the-patient dental delivery system. Figures 5 and 6 show a behind-the-patient system that is height and reach adjustable. Both systems were in the newer IHS dental clinics. The new clinics had over-the-patient (figures 3 and 4) or adjustable behind the patient (figures 5 and 6) dental delivery systems. Also noted in figures 5 and 6 is the "thin" profile patient dental chair. Figure 7 shows a good work practice by the dentist to raise the patient's chair so that the dentist's legs can fit underneath. Figure 8 shows the different working levels between the dental assistants and the dentists. Figure 9 shows a dentist with high neck flexion and poor upper back posture.

Ergonomic issues that we observed in older IHS dental clinics include:

- Parker (CRIT): poor maintenance of dental equipment, especially for one of the patient's chairs that had electrical and hydraulic malfunctions: the

dental and dental assistant chairs could not be easily adjusted; small (< 8' x 10') operatories and limited work space. [Note: the poor repair of the dental equipment was not the fault of personnel at the dental clinic, but a limited maintenance budget for equipment.]

- White River: limited operatory space; behind-the-patient dental delivery system; dental assistant chairs in poor repair.

- San Carlos: Old patient chairs that were over 8" thick which restricts the dentist and dental assistant from getting their legs under the chair to get closer to the patient; dental assistant chairs that can not be adjusted (especially the arm rests) because of broken plastic adjustment knobs. [Note: manufacturer should be notified about manufacturing defect and replace the plastic knobs with aluminum or steel-plated knobs.]

- Tuba City: limited work area behind the patient because of dental delivery system; high patient load (over 60 patients per day, with approximately 20 non-scheduled walk-ins); older dentist and dental assistant chairs that need to be replaced; quick set versus slow set dental amalgam increases hand forces during amalgam carving and shaping of tooth. There were very few ergonomic issues noted in the newer IHS dental clinics, except the heavy patient workload that averages approximately 65 patients per day at the Crown Point and Winslow IHS dental facilities. An adequate maintenance budget is needed to assure optimum performance of this equipment over time.

DISCUSSION

This study found a prevalence of neck MSD of 80% and a prevalence of shoulder MSD of 61% in dental workers for those workers completing the questionnaire. We do not know whether persons with an MSD are more likely to respond to the questionnaire. Still, this finding is greater than what has been previously reported in dentists by Milerad and Ekenvall who found that neck pain was reported by 54% of respondents and shoulder pain by 51%.¹⁰ These rates for dentists in that study were statistically significantly greater than those for pharmacists, and the authors attributed this increase to 1) cervical flexion and rotation, 2) abducted arms and, 3) repetitive precision-demanding handgrips.¹⁰ The

prevalence rates for musculoskeletal pain in this study are also greater than another study that reported upper extremity neuropathy in 29% of dentists. Cervical neuropathy was found in 46% of those, with neuropathy defined as “altered sensation” (which included pain, numbness, tingling, or loss of muscle function, with pain being the most commonly reported symptom).³⁸ Although the Milerad and Ekenvall paper only studied dentists, assistants at the IHS perform many tasks that are traditionally reserved for dentists, such as filling teeth. In this study, many of the risk factors found were applicable to all dental employees at the IHS.

The IHS used rear delivery systems almost exclusively due to concerns that children would kick the arm holding the hand pieces and interfere with the dentists’ work. Over-the-patient delivery systems, however, allow for bringing the hand pieces into the dentist’s or assistant’s work area with less twisting and also allow for proper transfer of hand pieces by the assistant. In “continental-style” delivery systems, the cords that supply the compressed air to the hand pieces retract and are kept away from the patient. These over-the-patient systems are easily adjusted for right or left handed dentists, and since the cords are not dangling over the patient, might be less vulnerable to kicking by pediatric patients. Side-delivery systems are also available. However, the assistant cannot reach the instruments with side-delivery equipment and the dentist must pick up and handle instruments and hand pieces. One of the clinics we evaluated had newer, “continental-style” equipment, and the IHS was experimenting with “continental-style” over-the-patient delivery systems. Having the hand pieces, air/water syringe, and instruments in front of the patient should lessen the need for reaching, twisting and leaning by the assistant and dentist.

Another potential problem that were seen by the NIOSH investigators was the location of the amalgamators and curing lights for composites. In some cases, amalgamators were not located near the assistant and it was necessary for the assistant to get up, mix the amalgam, and return to the work station. Because the IHS predominantly places amalgam fillings, amalgamators should be located near the assistants so that the amalgam may be mixed and handed to the doctor to reduce twisting or standing.

At the IHS clinics evaluated, most of the dental work involves dental restorations with amalgams,

extractions of infected teeth, and few crowns, fixed bridgework, or cosmetic dentistry. Assistants place and carve amalgams at the IHS clinics, a practice not usually permitted by state law in non-IHS clinics. Assistants receive instruction on how to place and carve amalgam from a dentist, and the work is then monitored by a dentist. Some clinics allowed assistants to place the large CPAs. Assistants reported that the amalgam carvers used were dull and that they could not properly carve the alloy. However, the IHS used an alloy (Tytin®) that sets very hard and quickly so that it is possible that the amalgam was setting too fast to be carved by hand. At one clinic, some of the assistants reported tendinitis that they believed was related to the instruments used. Ergonomically designed instruments are available that have the same function as the instruments that are presently used but have a thicker handle and are more easily grasped than the pencil-shaped instruments that were in the IHS clinics.

The finding that an increased number of extractions was associated with a lower prevalence of neck and back WRMDs may be due to the nature of oral surgery. Much oral surgery is done standing, and it is likely that each procedure was of shorter duration. More time spent on oral surgery means that less time is available for other procedures that may present more ergonomic risk. Also, oral surgery may be a marker for a break in operative dentistry or periodontal work and may be protective in that it involves a change of position. Rundcrantz et al,³⁴ found that significantly more dentists without pain and discomfort took advantage of the intermittent interruptions provided in their work (e.g., when the assistant was preparing the amalgam), using them for a rest or taking the chance to raise and lower their shoulders.

We found that fewer workers in the new clinics reported hand/wrist disorder than workers in the older clinics. These clinics were in the same geographic area, and workers did not vary by age, gender, number of CPAs done, or the number of quadrants scaled. The new clinics had newer equipment, with chairs that worked properly and had more employees who felt that their chair comfort was good or excellent (although not statistically different) than the old. This may facilitate better posture among employees.

The light that is available to a dentist may be an

important part of dental ergonomics. Much of dentistry uses reflected light and it is necessary to adjust the patient or the light to achieve maximal illumination. Unfortunately, it may be easier for the dentist to adjust his/her position to increase visibility and illumination, at the expense of musculoskeletal comfort. The doctor should not have to look up from the oral cavity to a less illuminated area to select a hand piece, which is required when selecting a hand piece with the rear delivery equipment used by the IHS.³⁹

The working positions of dental professionals vary depending on where in the mouth the dentist is working and on which surface of the tooth procedures are required. Among dentists with seats that could be tilted, very few used this feature of the chair. Ergonomic faults in positioning the patient lead to unfavorable postures for the dental professional.⁴⁰

Grace et al.⁴¹ found that the position in which the patient is placed in when first seated in the dental chair significantly determines the patient's final chosen position for optimum comfort. Patients who are first placed in an upright position will choose a position that is closer to upright. Similarly, patients who are first placed in a supine position choose a final position that is close to supine. If the patient is initially seated in a dental chair that has been preset in the horizontal or supine position, the study suggests that the patient will not experience discomfort sitting up and therefore will have no objections to this position. Eccles and Davies⁴² found that in low-line dentistry, hand pieces positioned in the mid-line above the patients are most convenient for operators working at the 9 and 12 o'clock positions, thus decreasing postural problems. However, mid-line position may not be accepted well by all patients.

From the job analyses information provided by the videotapes, pictures taken at the IHS clinics, measurements of the physical layout of the operatory and dental equipment, and informal interviews with dental assistants, it was determined that there were several ergonomic issues that needed to be addressed at the older clinics.

Figures 5 and 6 show a "thin" profile patient dental chair on a new delivery system. This chair is approximately 4" thick and tapers near the patient's head allowing dental personnel to get closer to the

patient by better leg clearance under the chair. Older chair models are approximately 6-8" thick, and dental personnel cannot easily get their legs under the patient's chair. The new delivery system allowed more options for the dentist and dental assistant to work in a comfortable position when performing surgery on a patient.

Dental assistants typically worked 5 – 7 inches higher than the dentist. The higher angle provides the dental assistant with a better view angle to help the dentist, but also causes them to have greater neck flexion than the dentist (Figure 8). Figure 9 shows a dentist with high neck flexion and poor upper back posture. Dental personnel should encourage their patients to turn their head in the direction and position that favors a more comfortable posture for the dentist to perform dentistry. This is especially true for dentists who wear magnifying glasses (Figure 10) where prolonged static loading of the neck muscles with little movement can cause discomfort and headaches, and possibly lead to musculoskeletal disorders in this area.

Figures 11 and 12 show a dental assistant and dentist, respectively, with abducted shoulders while working on a patient. Abducted shoulders by dental personnel were commonly seen in the older dental clinics; less so in the newer clinics because of thin profile dental chairs, and easily adjustable dentist and dental assistant chairs.

The number of employees at the visited sites was small. Thus, the results of this evaluation are primarily descriptive. NIOSH is conducting a more complete assessment of the relationship between musculoskeletal disorders and work at the IHS dental clinics among approximately 600 dental employees at all IHS clinics.

CONCLUSIONS

Prevalences of WRMDs in study participants ranged from a low of 6% (elbow pain), to a high of 48% (back pain). Higher symptom rates occurred in older clinics with rear delivery equipment and may be the result of improper posture, the twisting and turning needed to operate these units, and some malfunctioning equipment. Dental assistants (all

women) had higher prevalences of WRMDs than dentists (mostly men). Hand scaling was a risk factor for hand/wrist musculoskeletal disorders. Assistants tended to sit higher than dentists and had to flex their neck in order to see the dental procedure. In addition, they saw patients longer than the dentists. This combination of factors may result in the higher rate of WRMDs we saw in dental assistants.

RECOMMENDATIONS

NIOSH investigators recommend that the IHS do the following:

1. Replace older rear delivery equipment with more modern “continental-style” over-the-patient equipment. Utilize patient chairs that are as thin as possible.
2. Ensure that existing equipment is functioning properly and that all chairs are able to be raised and lowered within the range for which they were designed.
3. Design operatories so that the assistant or dentist does not have to get up or twist to use an amalgamator or curing light.
4. Make slow set amalgams available for use in CPA restorations.
5. Evaluate ergonomically designed instruments, particularly dental instruments with larger handles. The IHS could start with employees who are having hand/wrist WRMDs and assess their effectiveness before introducing them to all dentists at all clinics.
6. Remind staff of the importance of proper posture and periodically evaluate postures. Training courses should be offered concerning proper ergonomic technique for dental workers.
7. Finally, it was noted by NIOSH personnel that food and other items in the dental laboratory were not adequately separated from potential sources of contamination, both chemical and biological. We recommend that a separate designated area be identified, away from sources of contamination, where staff can have beverages and other food items.

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TABLE 1
CHARACTERISTICS OF THE STUDY POPULATION
HETA 98-0032-2795
INDIAN HEALTH SERVICE DENTAL BRANCH

CHARACTERISTIC	NUMBER	PERCENT
RIGHT HANDED	35/47	75
AMBIDEXTROUS	9/47	19
WEARS GLASSES TO WORK	29/46	63
NEARSIGHTED	13/47	67
WORKING POSITION IN RELATION TO THE PATIENT		
9 O'CLOCK	19/42	45
10 O'CLOCK	14/42	33
11 O'CLOCK	8/42	9
12 O'CLOCK	1/42	2
MIRROR USED OVER 50% OF THE TIME	29/45	64
HANDPIECES BEHIND PATIENT	46/47	98
DOCTOR'S CHAIR COMFORT GOOD OR EXCELLENT	22/47	47

TABLE 2
PREVALENCE RATES ¹ OF WORK-RELATED MUSCULO SKELETAL DISORDERS BY AGE OF CLINIC, GENDER, AND OCCUPATION
HETA 98-0032-2795
INDIAN HEALTH SERVICE DENTAL BRANCH

	BODY AREA ²							
	NECK		SHOULDER		HAND/WRIST		BACK	
PREVALENCE OF SYMPTOM								
PREVALENCE RATE OF ALL MUSCULOSKELETAL DISORDER CASES	N=46	80%	N=42	61%	N=43	61%	N=44	85%
PREVALENCE RATE OF WRMDs	N=43	48%	N=42	37%	N=42	31%	N=42	42%
CLINIC TYPE								
NEW CLINIC	N=15	9%	N=14	12%	N=12	8%	N=12	42%
OLD CLINIC	N=29	39%	N=29	26%	N=30	40%**	N=31	42%
GENDER								
MALE	N=12	8%	N=12	25%	N=12	8%	N=12	17%
FEMALE	N=32	63%*	N=31	42%	N=30	40%**	N=31	52%
OCCUPATION								
NON-DENTIST	N=30	63%	N=28	43%	N=28	42%	N=28	50%
DENTIST	N=12	8%*	N=13	23%	N=13	0%*	N=13	31%

* P<0.05

**P<0.10

¹THE NUMBER OF EMPLOYEES WHO HAD THE WRMD DIVIDED BY THE NUMBER OF EMPLOYEES IN THAT GROUP

²ONLY 7 EMPLOYEES REPORTED OF ELBOW PAIN (16%), AND ONLY 3 WORKERS REPORTED WR ELBOW PAIN (7%)

TABLE 3
PREVALENCE RATES^A OF WORK-RELATED MUSCULO SKELETAL DISORDERS BY
AGE,, WEIGHT, HEIGHT, YEARS IN DENTISTRY AND NUMBER EXTRACTIONS PERFORMED
HETA 98-0032-2795
INDIAN HEALTH SERVICE DENTAL BRANCH

			NECK DISORDER PREVALENCE		HAND/WRIST DISORDER PREVALENCE		BACK DISORDER PREVALENCE		SHOULDER DISORDER PREVALENCE
AGE	36 YEARS OR MORE	N=25	32%	N=22	36%	N=24	45%	N=23	48%
	LESS THAN 36 YEARS	N=19	60%**	N=20	25%	N=19	37%	N=20	25%
HEIGHT	64" OR MORE	N=24	38%	N=22	32%	N=25	32%	N=23	27%
	LESS THAN 64"	N=20	60%	N=20	30%	N=18	56%	N=20	50%
WEIGHT	170 LBS. OR MORE	N=20	55%	N=21	19%	N=22	32%	N=21	33%
	LESS THAN 170 LBS	N=23	40%	N=21	42%**	N=21	52%	N=22	33%
YEARS IN DENTISTRY	9 YEARS OR MORE	N=22	25%	N=18	33%	N=20	45%	N=20	40%
	LESS THAN 9 YEARS	N=22	41%	N=24	29%	N=23	40 %	N=23	35%
HAND SCALING	NOT DOING HAND SCALING	N=23	40%	N=29	31%	N=23	39%	N=23	14%
	DOING HAND SCALING	N=20	55%	N=13	69%*	N=19	47%	N=19	21%
EXTRACTIONS	10 EXTRACTIONS OR MORE	N=19	26%	N=21	24%	N=20	25%	N=20	30%
	LESS THAN 10 EXTRACTIONS	N=25	64%*	N=21	38%	N=23	57%*	N=23	43%

* P <0.05

**P<0.10

^A The denominator changes for each symptom and risk factor subgroup due to missing data.

TABLE 4
PATIENT, DENTIST, AND DENTAL ASSISTANT EXPOSURE TIME AT THE IHS DENTAL CLINICS EVALUATED BY NIOSH RESEARCHERS
HETA 98-0032-2795
INDIAN HEALTH SERVICE DENTAL BRANCH

Dental Facility	Operation Number	Patient exposure time (minutes)	Dentist exposure time (minutes)	Dental Assistant Exposure time (minutes)
White River	1	34	29	29
	2	49	13	48
	3	30	13	27
	Average time (min)	37.7	18.3	34.7
San Carlos	1	52	6	24
	2	27	24	20
	Average time (min)	39.5	15.0	22.0
Crown Point	1	44	28	38
	2	32	8	26
	3	54	43	40
	Average time (min)	43.3	28.3	34.6
Winslow	1	31	9	10
	2	23	15	6
	3	44	6	7
	4	11	6	8
	Average time (min)	27.3	9.0	7.8
Tuba City	1	70	26	53
	2	12	4	5
	Average time (min)	41.0	15.0	29.0
Average time per patient for all dental facilities visited (minutes)		36.6	16.4	24.4
Time spent with patient			45%	67%

TABLE 5
OVERVIEW OF PHYSICAL FEATURES AND ERGONOMIC ISSUES FOR HIS DENTAL CLINICS VISITED BY NIOSH RESEARCHERS
HETA 98-0032-2795
INDIAN HEALTH SERVICE DENTAL BRANCH

Dental Clinic	Date visited	Number of Operations Observed	Delivery System
CRIT (Parker)	02-09-98	No video taken	Rear delivery system. Powered dental instruments on roller cart about 30" high, all manual instruments put on cabinet counter about 34" high in back of patient. Dental work area is cramped, and some dental patient's chairs are in poor repair and need of replacement hydraulics.
White River	02-10-98	3	Rear delivery system. Powered dental instruments on roller cart about 30" high, all manual instruments put on cabinet counter about 34" high. Dental chairs are in good repair. Dental assistant has armrest.
San Carlos	02-11-98	2	Rear delivery system. Powered dental instruments on roller cart about 30" high, all manual instruments put on cabinet counter about 36" high in back of patient. Dental equipment is in fair condition.
Crown Point	11-03-98	3	Rear and Over the Patient delivery systems. First two operations: Rear delivery – instrument tray on roller stand about 30" high; last operation: over the patient delivery system with new chairs for dentist, dental assistant, and patient.
Winslow	11-04-98	4	New dental facility. Real delivery system with adjustable height platforms attached to an island cabinet about 3' wide and 6' tall with a cabinet attached to the top of the platform starting at about 4'. This facility had been in operation for about 1 month before our arrival. (Peltone Crane chairs for dentists and dental assistants – with arm rests and foot rings.) New A-Dec chairs for patients (broad back and base, but thin profile chairs to make it easier for dentists and dental assistants to get their legs under the patient and be closer to perform their work). The dental equipment tray can swing out from cabinet unit and be adjusted to the working level (mid-chest level) of the dentist. Activities by dental assistant: set up dental equipment trays, prep patients (i.e., rubber dams), clean up area when patient is done (use spray disinfectant bottle on chairs, equipment).
Tuba City	11-05-98	2	Rear delivery system. Modular units all on rollers that fit under cabinets behind the patient. One unit is about 30" high which has the dental power tools; the other unit is about 34" high which has the manual tools. The power tool unit is on the dentist's side; the manual tool unit is on the dental assistant's side. Dental furniture (A-Dec) is not new, but does not appear to be in poor repair. Work volume is high.

TABLE 6
IHS DENTAL CLINIC ATTRIBUTES AND MUSCULOSKELETAL RISK FACTORS
IDENTIFIED FOR EACH IHS DENTAL FACILITY EVALUATED BY NIOSH RESEARCHERS
HETA 98-0032-2795
INDIAN HEALTH SERVICE DENTAL BRANCH

Dental Facility	Old/New Clinic	Delivery system	Risk factors for dentist	Risk factors for dental assistant
CRIT (Parker)	Old	Behind the patient	Dentist chair and patient's chair is poor repair (hydraulics don't work); cramped work space in dental operatory especially between patient's chair and dental equipment cabinet behind patient. Limited space behind patient does not allow dentist to work in 11:00-12:00 o'clock position causing awkward postures for some dental procedures, patient scheduling and work pace high.	Dental assistants chair is older model, and is not easily height adjusted for assisting dentist during surgery. Behind the patient delivery system and thick patient chairs (older models 6-8") forces dental assistants to work with their torso twisted (about 60-70 degrees), to lean forward (about 20 degrees), and have an extended reach (18-24") during surgery.
White River	Old	Behind the patient	Limited work area in dental Operatory (8 x 10' by design), but with behind the patient delivery system and with cabinets the actual work area for the dentist is less than square feet, work scheduling for patients does not vary, and work pace is high.	Dental assistant arms rests are not adjustable (rusted or broken adjustment knobs on many chairs), patent load is high, quick set amalgam may increase hand forces while performing expanded functions dental work.

TABLE 6 continued
IHS DENTAL CLINIC ATTRIBUTES AND MUSCULOSKELETAL RISK FACTORS
IDENTIFIED FOR EACH IHS DENTAL FACILITY EVALUATED BY NIOSH RESEARCHERS
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Dental Facility	Old/New Clinic	Delivery system	Risk factors for dentist	Risk factors for dental assistant
San Carlos	Old	Behind the patient	Limited work area due to behind the patient delivery system, extended reach and high back flexion due to thick patient chairs (note, some patient chairs are being replaced by new patient chairs that have thin profiles). Dental chairs not easily adjustable, lack lumbar support. High patient load.	Adjustment knobs on many dental assistant chairs are broken (because they are made of cheap plastic and not metal), and the chairs cannot be easily adjusted especially the arm rests. Dental assistants sit approximately 5-7" higher than dentists for better view of patient and to assist, but this causes higher neck and back flexion compared to dentist. High patient load.
Crown Point	New	Over the patient	Very few risk factors observed for dentists at this facility. New facility, good layout and design. Over the patient delivery system in some operatories. New thin profile patient chairs, allowing dentists to get their legs under patient and reduce forward reach and neck and back flexion, high patient load approximately 66 patients per day for 4 dentists and 12 dental assistants.	Very few risk factors observed for dental assistants at this facility. New dental assistant chairs have greater height adjustment range (18 – 30") than older chairs (23 - 30") allowing dental assistants to put their legs under patient's chair thus reducing reach distances, and neck and back flexion when assisting dentist.

TABLE 6 continued
IHS DENTAL CLINIC ATTRIBUTES AND MUSCULOSKELETAL RISK FACTORS
IDENTIFIED FOR EACH IHS DENTAL FACILITY EVALUATED BY NIOSH RESEARCHERS
HETA 98-0032-2795
INDIAN HEALTH SERVICE DENTAL BRANCH

Dental Facility	Old/New Clinic	Delivery system	Risk factors for dentist	Risk factors for dental assistant
Winslow	New	Behind the patient with adjustable arm and height adjustment	Very few risk factors observed for dentists at this facility. Excellent natural lighting. Behind the patient delivery system is height adjustable (hydraulic), and pivots away from modern island cabinet up to 32" for easy access by dentist. This system is not as easy to use if dentist wants to work in the 12 o'clock position (i.e., top of patient's head), but can be done with new pivot arm and space between patient. Need maintenance budget for equipment (found hydraulic failure on one dental delivery unite during survey). Excellent work atmosphere between dentists and dental assistants, high patent load.	Very few risk factors, new height and reach adjustable patient delivery system reduced reaches, but still caused dental assistants to twist their back while assisting dentists during surgery. Consider installing "hands free" wash basins to reduce infectious disease transmission.
Tuba City	Old	Behind the patient	Limited work area with behind the patient delivery system. High patient volume (approximately 60 per day, with approximately 20 non-scheduled walk-ins). Older chairs cause dentists to extend their reach and have neck and back flexion during patient surgery. Other stressors: isolation, high workload, older equipment that is not adjustable to fit the dentist while performing surgery.	Dental assistant expanded functions issues: quick versus slow set amalgam. Quick set anal gum provides faster patient processing, but causes higher forces in the dental assistants hands when using dental instruments to carve the amalgam. Slow set amalgam reduces forces in dental assistants hands but may slow down patient processing. Work organization, and varying patient loads are stressors.



Figure 1: Behind the patient dental delivery system, most commonly found in older IHS dental facilities.

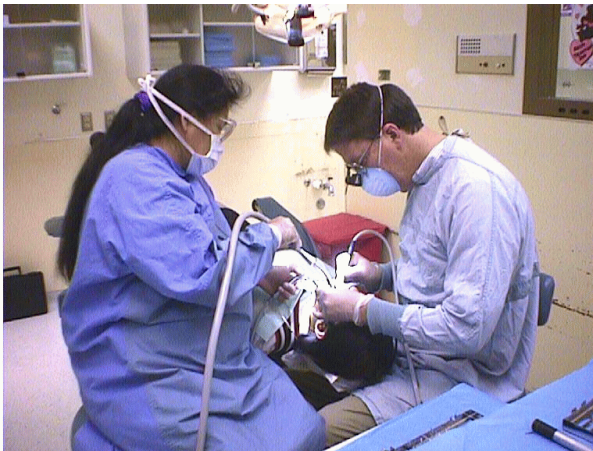


Figure 2: Dental Assistant twisting her upper body to the left while her lower body faces the delivery system for quick access to dental equipment.



Figure 3: Over the patient dental delivery system, most commonly found in modernized or new HIS facilities.



Figure 4: Over the patient dental delivery system, top view.

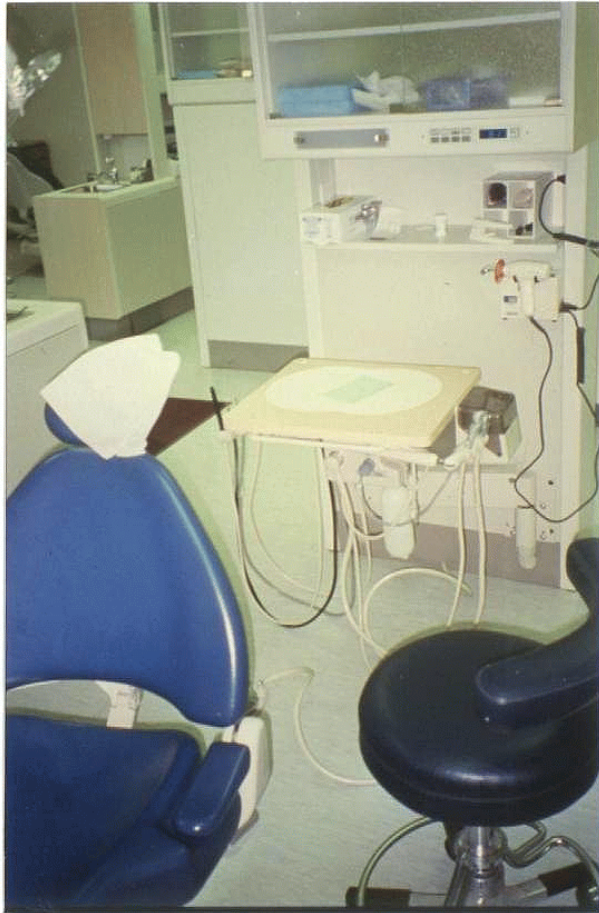


Figure 5: Modern behind the patient dental delivery system (platform can be adjusted up or down, in or out (up to 38") according to the preferences of the dentist and/or dental assistant during dental surgery.



Figure 6: Modern behind the patient dental delivery system being used by dental assistant. Thin profile chair gives more leg for dentists and dental assistants to get closer to patients during dental surgery.



Figure7: Proper elevation of patient for dentist's legs to move under patient's chair reducing reach and awkward back posture.



Figure 8: Higher work height (about 5 – 7”) of dental assistant (pictured on left) compared to dentists may result in a greater degree of neck flexion for longer periods of time during surgery compared to dentists.



Figure 9: High neck flexion by dentist, and forward back flexion by dental assistant during dental surgery.

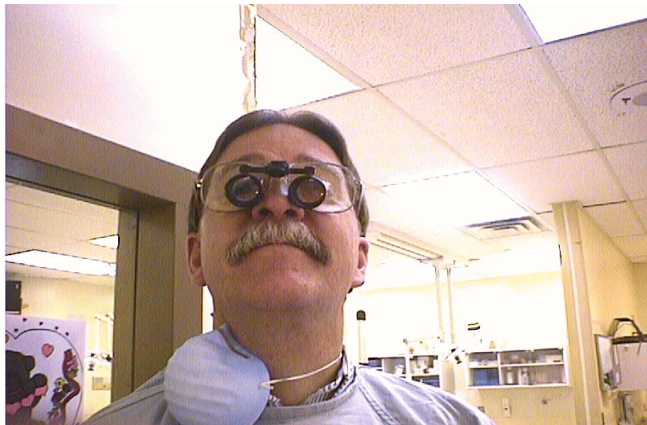


Figure 10: Magnifying glasses to focus on detail work during dental surgery. Focusing in one area for prolonged periods may increase risk for neck and shoulder discomfort.



Figure 11: Right shoulder abduction and extended reaches by dental assistant during dental surgery may results in shoulder discomfort.



Figure 12: Abducted shoulders by dentist during dental surgery. Static loading of shoulders in combination with shoulder abduction may increase the risk of shoulder musculoskeletal discomfort leading to musculoskeletal disorders.

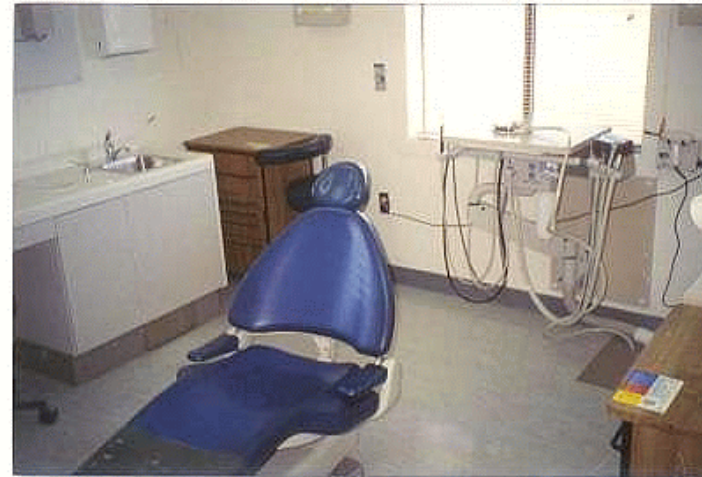


Figure 13: Dental operatory layout with NIOSH assisted design located in Cincinnati, Ohio. Note thin profile patient chair, larger room 12' x 12', and behind the patient wall mounted, pivoting table, dental delivery system. All designed to aid the dentist and dental assistant in improving patient care and reducing musculoskeletal disorders.

For Information on Other
Occupational Safety and Health Concerns

Call NIOSH at:
1-800-35-NIOSH (356-4674)
or visit the NIOSH Homepage at:
<http://www.cdc.gov/niosh/homepage.html>



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