Among the small number of clinical studies of treatments for TMD patients, there is little documented involvement of patients with a history of multiple treatments or treatment failures. As is the case for many areas of health care in which new or alternative treatments are being evaluated, clinical studies in this field tend to enroll patients with new disease or with limited comorbidities, in order to limit the potential for these factors to confound any observed treatment effect. This limits opportunities to determine what types of treatment may be effective in salvaging treatment failures, particularly from invasive treatments, or otherwise improving functional status and pain in this special subgroup of TMD patients.

B. Cost literature

1. Overview

Main categories of health care costs include direct health care costs (including medical, dental, and other), direct non-health care costs, indirect costs, and intangible costs. Direct health care costs refer to changes in resource use attributable to health care interventions such as the costs of physician services, hospital services, pharmaceuticals, and associated administrative costs. Direct non-health care costs refer to other costs associated with accessing care, such as for patient transportation and child care. Indirect costs are usually those associated with productivity losses due to illness or death.[1] Intangible costs are those of pain and suffering; although they are rarely quantified in economic terms, pain and suffering can be quantified as part of quality of life and health status measures.

Ideally, measurement of direct health care costs would entail actuarial determinations of the various resource inputs for providing health care. However, making true cost determinations can impractical and expensive. Most studies use more readily available surrogates for true costs, such as health care prices, charges, or payments.

Health care costs are often weighed against health care benefits or outcomes in such analyses as cost-effectiveness analysis, cost-utility analysis, and cost-benefit analysis. These typically involve comparisons of marginal changes in health outcomes as a function of marginal changes in health care costs. At a macroeconomic level, cost analyses involve determinations of, e.g., the impact of a disease or of health care interventions for various diseases on national health care expenditures.

The economic focus designated for this study is the per-patient costs of TMD treatment. These are direct health care costs of treatment. Given the content of the earlier literature and the expectations of our stakeholder interviewees, however, we anticipated a limited body of literature on this topic. Therefore, we were prepared to refer to published as well as unpublished

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[1] For example, a study conducted in Finland found that patients with TMD had higher rates of self-reported sick leave, in addition to higher health services utilization. The most common reported causes of sick leave were influenza and psychological causes (Kuttila et al. 1997).

literature that was available on other types of costs or other types of cost analyses if it included information that could provide insight regarding per patient costs of TMD treatment.

Consistent with the experience of several of our stakeholder interviewees and earlier literature, we found the available literature on the per-patient costs of TMD to be scarce. A MEDLINE search using such search terms as "costs and cost analysis," "cost," "cost-benefit analysis," and "cost-effectiveness" combined with the search terms related to TMD yielded 94 articles published since 1996 (see Methodology section). Of these 94 articles, five were determined to be relevant to this report (Kuttila et al. 1997; Moenning et al. 1997; Scarfe et al. 1998; Shimshak and DeFuria 1998; Shimshak et al. 1997). Stakeholders interviewed for this report called our attention to two additional relevant reports (The TMJ Association, unpublished; White et al. in press). Appendix B provides a summary of these seven studies.

Though not directly relevant to the purpose of this study, it is worth noting that we found no indication of the magnitude of national spending on TMD, although a 1993 study estimated that total U.S. spending for treatment of orofacial pain was roughly $32 billion per year (Sears 1993).

2. Per-patient Costs

There is no consensus or recognized convergence in the published literature or other sources that we identified regarding the direct health care costs associated with TMD treatment. However, a small set of retrospective studies of TMD patients drawn from large health plans, including two case control studies and one cohort study with a contemporaneous comparison group, provide information than can be used to derive estimates of the per patient costs of TMD treatment. These studies, along with a small number of other studies pertaining to costs, are described below. The ongoing NIDCR-funded RCT of four types of treatment for TMD being conducted by Schiffman et al. (2000, December) is collecting direct-cost data as part of the study.

a) Study of a large insurer, 1989-1990

In a retrospective case control study using the administrative database of a major medical insurer, Shimshak et al. (1997) compared the medical claims profiles and costs of 1,819 matched pairs of patients with and without TMD. The study covered patients who had been enrolled continuously in the Master Health Plus health plan, offered by Blue Cross Blue Shield of Massachusetts, during the two-year period 1989-1990. Members of this plan received first-dollar coverage for physician services, inpatient and outpatient care, and prescription drugs. However, the benefit for TMD disorders was limited to a reimbursement of $750 over a two-year period. Dental claims were not available for analysis, since the insurer did not offer dental insurance. (Some care from dentists that qualified under the medical insurance plan was included.)

The TMD cases (patients with TMD), were selected on the basis of having at least one paid claim (physician or other professional) in the two-year period having a diagnosis of one of the following four ICD-9-CM codes: Temporomandibular joint disorders (524.60), Dislocation of jaw, closed (830.00), Dislocation of jaw, open (830.10), and Sprain of jaw (848.10). Of these

four codes, nearly 95% of the claims for the TMD cases were diagnosed with 524.60. A total of 1,819 TMD patients were identified with these codes. The control patients (non-TMD patients) were matched to the cases based on age, sex, relationship to subscriber, and employer group.

Across the population of 1,819 TMD patients, the total payments for all types of claims combined during the two-year period amounted to $10.8 million, compared to $5.4 million for the matched non-TMD population, i.e., a ratio of 2:1. This amounted to a mean of $5,945 per TMD patient and $2,973 per matched control patient for the two-year period, a statistically significant difference ($p<0.0001$). Of the $10.8 million in total payments for all types of claims among TMD patients, only $483,000, or less than 5%, was attributable to the four ICD-9 codes for TMD. Though not reported by the investigators, this amounts to just $266 per TMD patient for the two-year period. Clearly, most of the care provided for patients with TMD is not associated with the procedure or diagnosis codes used to identify TMD patients. (The cost figures provided in this study appear to be in current dollars, not adjusted for inflation.)

In addition to the four TMD codes that were used to select the 1,819 cases, the investigators examined payments associated with an additional 29 diagnoses that were defined as being related to TMD. (This set of codes was drawn from the set of 29 "TMJ-related" diagnoses identified by Blue Cross Blue Shield of Minnesota and used to define coverage for all health plans in that state.) Among the 29 TMJ-related diagnoses, the codes with the most claims were: Myalgia (729.10), Mixed tension/vascular (346.90), rheumatoid arthritis (714.00), Muscle spasm (728.55), and Muscle tension headache (307.81). Among the TMD cases, 408 claimants for any of these additional codes accounted for payments of $83,519, while among the controls, 123 claimants accounted for payments of $29,829, for a ratio of 2.8 in total payments. Thus, the payments for TMD patients for claims for the four main TMD codes plus the 29 additional TMJ-related diagnoses raises the cost of TMD-related care to about $567,000, or 5.25% of total health care expenditures for TMD patients (Table 7).

Table 7: ICD-9-CM Codes attributed to TMD

	ICD-9 Code	Diagnosis Description
TMJ Diagnostic Codes	524.60	Temporomandibular joint disorders
	830.00	Dislocation of jaw, closed
	830.10	Dislocation of jaw, open
	848.10	Sprain of jaw
"TMJ-Related" Diagnostic Codes*	306.80	Bruxism
	307.81	Muscle tension headache
	316.00	Psychological factors
	346.00	Migraine, classic
	346.10	Migraine, common
	346.20	Cluster headache
	346.80	Migraine, hemiplegic
	346.90	Mixed tension/vascular
	350.10	Trigeminal neuralgia
	352.10	Glossopharyngeal
	352.90	Occipital
	446.50	Temporal arteritis
	524.10	Asymmetry of jaw
	524.20	Dental arch malrelationship
	524.40	Malocclusion, unspecified
	714.00	Rheumatoid arthritis
	715.00	Osteoarthritis, generalized
	716.10	Arthropathy, traumatic
	728.00	Myotis, infective
	728.81	Myotis, interstitial
	728.85	Muscle spasm
	729.10	Myalgia
	733.99	Eagles syndrome

Adapted from Shimshak et al. 1997
* Six TMJ-related diagnostic codes were not utilized in the study and are excluded from the table

The ratio of total payments for cases compared to controls was 2.2 among females and 1.7 among males. During the two-year period, the number of claims for any of the four ICD-9 codes for TMD among the cases was 4.9 for females and 2.9 for males, although the mean amount paid per claim was $57 for females and $76 for males. Just 13% of the TMD patients accounted for 58% of total claim payments. These 13% of TMD patients accounted for $3.85 million of the $5.4 million (71%) of the difference in total payments between cases and controls.

The magnitude of differences in utilization and costs of care between the TMD and non-TMD patients extended over a variety of diagnostic categories. The bulk of the cost differences between the TMD patients and non-TMD patients were attributed to diagnoses or conditions that were not usually considered related to TMD. Among the categories for which inpatient admissions for TMD patients exceeded those of non-TMD patients by a factor of at least 2:1, the most common were: digestive system, mental disorders, circulatory system, injuries/accidents,

respiratory system, musculoskeletal, and nervous system. Differences between TMD and non-TMD populations were also found regarding costs and utilization of drugs, particularly for narcotics, anti-inflammatories, and psychotropics.

The investigators did not annualize the cost findings of the study. Converting these figures to an annual basis, the total payments for all types of claims was $2,973 per TMD patient per year, compared to $1,486 per non-TMD patient per year. Payments for only the four diagnoses most closely identified with TMD amounted to $133 per TMD patient per year. If the payments for claims for the additional 29 TMD-related diagnoses are included along with the original four diagnoses for TMD, then the payments for TMD-related diagnoses increase to $156 per TMD patient per year.

As noted by the investigators, the TMD health benefit for the insurer in this study was new. So, some people with TMD might not have sought care under the health benefit plan or might have received care from a dentist that did not show up in the data. Also, other patients diagnosed with TMD before or after the 1989-1990 study period would not have appeared as TMD patients in this study, since claims paid by other carriers would not have been available for analysis. As noted above, these payments came from a database of an insurer that did not offer dental insurance, and therefore did not capture most care that was provided to these patients by dentists.

b) Study of a large managed care organization, 1994

In a subsequently report, Shimshak and DeFuria (1998) examined 1994 claims data from a New England managed care organization with a large, mixed geographic population. TMD patients were identified using a proprietary diagnosis code grouping methodology comprising 17 ICD-9 codes related to TMD. Out of a total patient population of 534,198, there were 1,713 patients who incurred at least one claim from among these codes in 1994. The remaining 532,485 enrollees, who had no claims in the set of 17 TMD codes, including nearly 40,000 who received no health care services that year, were designated the comparison group for this study. Data for the non-TMD patients were adjusted for age and sex in order to be used as a basis of comparison. The study accounted for inpatient claims, outpatient claims, and psychiatric inpatient and outpatient claims, measured separately.

The magnitude of the differences in utilization and cost of health care services between TMD and non-TMD patients extended over a wide range of diagnostic categories. Except for pregnancy and childbirth, the per capita hospital admissions for TMD patients were higher than those for non-TMD patients for every major diagnostic category with a substantial number of admissions. The inpatient cost per capita for TMD patients was more than 80% higher than for non-TMD patients, i.e., $936 vs. $517. Even when the cost of all TMD-specific claims (i.e., excluding claims in the 17 TMD-related diagnoses) was excluded, the inpatient cost per capita for TMD patients was more than 46% greater than for non-TMD patients, i.e., $753 vs. $517. Similarly, the outpatient cost per capita for TMD patients was twice that for non-TMD patients, i.e., $1,738 vs. $870. When the cost of all TMD-specific claims was excluded, the outpatient costs per capita for TMD patients was 79% greater than for non-TMD patients, i.e., $1,560 vs.

$870. The differences in per capita psychiatric costs, both for inpatient ($35 vs. $16) and outpatient ($64 vs. $38) costs, measured separately from other inpatient and outpatient costs, also varied by a factor of about 2:1. The removal of the nearly 40,000 enrollees who received no health care services during the year had a negligible effect on the magnitude of cost differences between the groups. (The cost figures provided in this study appeared to be in current dollars, not adjusted for inflation.)

Based on the costs reported by the investigators, the total annual inpatient, outpatient, and psychiatric costs were $2,773 per capita for the TMD patients and $1,440 for the non-TMD patients. Of the difference in the groups of $1,333, the amount due to costs associated only with the group of 17 ICD-9 codes related specifically to TMD was $361. Thus, the cost of care for the TMD-specific diagnoses constituted 13% of the total cost of care for TMD patients and 27% of the difference in cost of care between TMD and non-TMD patients. (These summations of total annual per patient costs and differences were not provided in the published article.)

Dental claims were not part of the data set, and it is likely that some enrollees received care from dentists. Other enrollees might have been treated for TMD before or after the 1994 study year, and would not have appeared as TMD patients in this study.

c) Study of a large health maintenance organization, 1990-1995

White et al. (in press) conducted a case-control study of health care utilization and costs involving 8,800 TMD patients who were continuously enrolled members of Kaiser Permanente Northwest during the six-year period 1990-1995. TMD cases were identified as those enrollees who had at least one TMD clinic visit or one TMD-related procedure during the six-year study period. The eligible set of TMD-related procedures included four CPT codes and 18 ICD-9-CM procedure or diagnosis codes. An equal number of control subjects were identified and matched to the cases using 14 variables, including age and sex. The mean age for both groups was 40.5 years, 80% were female, and 70% were between the ages of 20 and 50.

Costs included in the study were outpatient visits (including mental health visits), outpatient pharmaceuticals, radiological services, TMD clinic visits, dental visits, inpatient admissions, and outside claims for outpatient and inpatient services. The investigators separated TMD clinic services from other dental services by identifying a set of procedure codes used only by TMD clinic providers.

TMD patients used more of all types of services than those without TMD. On average, TMD cases had 57% higher costs for all services than did controls, i.e., $15,996 vs. $10,174 (adjusted to 1995 dollars) over the course of the six-year study period. The median costs for TMD cases was 93% higher than the non-TMD controls, i.e., $9,421 for the TMD cases and $4,879 for the non-TMD controls. The investigators did not report the specific costs associated with only the CPT and ICD-9-CM codes used to identify TMD patients.

The differences between TMD patients and non-TMD patients in health care utilization and costs was consistent over a wide range of services. However, these differences were largely attributable to services other than for diagnostic categories closely related to TMD itself. Of the difference in mean costs between the two groups, 39.6% was attributable to outpatient visits, 23.8% to inpatient admissions, 12.1% to outpatient pharmaceuticals, and 7.5% to radiological services. Only 6.8% of the difference was due to TMD clinic visits, and 4.4% to dental visits. Outside claims for outpatient and inpatient services accounted for the remaining 5.8% of the difference in average costs between the two groups.

About 10% of TMD cases and non-TMD controls accounted for 40% and 47% of the costs in each group, respectively. About 30% of patients in each group accounted for more than two-thirds of all costs. The median cost of inpatient care for both groups was zero, as most health plan enrollees are not hospitalized in any six-year period. The median cost of dental care for the TMD cases was $292 (or about $49 per year) and zero for the non-TMD controls. During the six-year study period, TMD patients made an average of 3.26 visits to the TMD clinic. TMD patients also made an average of 7.46 dental visits, compared to 5.28 dental visits by non-TMD controls.

Over the six-year period, the average per patient cost for TMD cases was $2,661, compared to $1,696 for non-TMD controls. Of the difference in the groups of $965, 11.2%, or about $108, was due to TMD clinic visits (6.8%) and additional dental visits (4.4%) by TMD patients. (The determinations of annual per patient costs were not provided by the authors.)

3. Patient Out-of-Pocket Costs

Given that much of the care for TMD is not captured by health plan data sets, per patient out-of-pocket costs are poorly documented. To the extent that various TMD interventions are not covered by insurance, out-of-pocket costs would be expected to comprise a larger proportion of total per-patient costs. The TMJ Association (2000c) has unpublished data from a 1999 survey of TMJ patients known by the association concerning sociodemographic characteristics, insurance status, out-of-pocket costs, and other information. There were 187 respondents out of an unspecified number of people contacted for the survey. Respondents were asked to "Estimate your out-of-pocket costs (not covered by insurance) for TMJ treatments (include medications)." Among the 130 people who responded to this item, reported average out-of-pocket expenditures was $40,160. The average out-of-pocket expenditures for respondents identifying themselves as implant patients and as non-implant patients were $68,371 and $13,642, respectively. However, neither the questionnaire nor the reported results addressed the time period for these expenditures. Reported out-of-pocket costs fell into the $1–$4,999 range for 29% of these respondents, into the $5,000-9,999 range for 10% of respondents, and into the $10,000-$49,999 range for 40% of the respondents. Six respondents reported out-of-pocket expenditures in excess of $200,000, including two in excess of $500,000. These outlier estimates have a sizable effect on the reported average estimate of $40,160. No median estimate was provided.

Although The TMJ Association survey provides some rough information about out-of-patient costs as estimated by a selection of TMD patients, it is subject to various potential biases. Among these are self-selection bias by patients choosing to become members of The TMJ Association, self-selection for high cost experience patients in response to a survey about costs, and respondent recall bias.

A wide range in the magnitude of out-of-pocket costs also was reported in an earlier study by Garro et al. (1994). Based on interviews of 32 members of a TMD support group, self-reported out-of-pocket costs ranged from $35 to $40,000. Half of the subjects reported out-of-pocket costs of $5,000 or more, and more than one-fourth reported costs of $10,000 or more. However, the report did not address the time period over which these expenses were incurred.

The available information concerning out-of-pocket costs for TMD patients is very limited and subject to methodological weaknesses. Nevertheless, it does provide further indication of there being a TMD patient population that has experienced very sizable out-of-pocket costs while pursuing treatment for health conditions that can be painful, debilitating, and intractable.

4. Other Types of Cost Studies

Studies (both published and unpublished) exist that report on health services utilization and costs associated with treating certain subgroups of TMD patients or on particular procedures or protocols for treating certain types of patients in specific settings. However, these reports generally are not representative of the broader TMD population. For example, one study indicated that TMD surgical interventions may result in reduced TMD costs due to a decreased need for health services subsequent to surgery (Moenning et al. 1997). Based on patient self-reported data, TMD patients in that study were found to spend $7 less per month on medications subsequent to orthognathic surgery (to align the jaw) and require fewer physician visits.

As part of a business plan for the purposes of documenting the utility of opening an orofacial pain center, the National Naval Dental Center used a modeling approach to estimate per patient costs for treating orofacial pain. The analysis incorporated specific codes for procedures that would be used to treat patients in this setting. This analysis indicated that the per patient cost for treating patients with orofacial pain in a pain management clinic would be $267 per one hour session for an average of five visits per patient, for a total of $1,335 per patient (Stakeholder interview February 2, 2001). However, the selection of hypothetical patients with orofacial pain likely overlaps, but does not represent well, the TMD populations of other studies. Further, the new pain treatment protocol proposed for these patients is not representative of prevailing treatments of TMD.

5. Payment

The imprecise nature of TMD hinders the ability of payers to identify and make appropriate payment decisions concerning its diagnosis and treatment. Indeed, current coverage patterns for TMD treatments vary widely. In some states coverage is legislatively mandated rather than

being determined by health plans or other health care payers. Many private insurers only partially cover care for TMD, or do not provide coverage at all with benefit packages specifically excluding coverage for it. As a result, out-of-pocket costs for some affected individuals can be substantial, though estimates of the magnitude of these costs among the TMD population are not well documented.

Payers remain concerned that adequate evidence does not exist to demonstrate that many treatments for TMD improve the condition of these patients, and that some treatments may worsen patients' conditions. Many payers who are familiar with the TMD literature are aware that symptoms spontaneously subside in large portions of the TMD patient population, raising questions about the utility of treating across the TMD population and concerns about the potential adverse sequelae of more invasive treatments. Moreover, payers are concerned about the accuracy of tests used to diagnose TMD. Payers report preferring more objective tests for diagnosing TMD, such as radiographic evidence, as opposed to more subjective ones (Payer interview, 2000). Even so, while some payers acknowledge that MRI has utility in demonstrating physiological signs that are sometimes associated with TMD, they are not convinced that there is a clear connection between apparent TMD on MRI and symptoms.

Payers express receiving increased pressure to pay for TMD interventions (Payer interview, 2000). The Health Care Financing Administration (HCFA) allows coverage of surgical procedures for TMD under Medicare, but not non-surgical treatments. As is the case for many types of health care procedures, many large private payers are influenced by the coverage policies of HCFA.

Though some states have mandates to pay for TMD interventions, these typically specify coverage for certain treatments only. According to a compilation of the American Dental Association, the following 19 states have laws, regulations, or directives requiring health insurance policies issued within the state to include coverage for the diagnosis and treatment of TMD: California, Florida, Georgia, Illinois, Kentucky, Maryland, Minnesota, Mississippi, Nevada, New Mexico, North Carolina, North Dakota, Tennessee, Texas, Vermont, Virginia, Washington, West Virginia, and Wisconsin. States typically place some payment bounds on these requirements, e.g., Illinois: maximum lifetime at least $2,500; Mississippi: maximum lifetime at least $5,000; North Carolina: maximum lifetime benefit $3,500; North Dakota: maximum lifetime benefit $10,000 for surgical and $2,500 for non-surgical treatment; and Wisconsin: annual maximum $1,250 (ADA 2000).

As occurs for certain other types of health care interventions, legislative mandates to cover interventions for TMD can circumvent payers' efforts to implement evidence-based coverage policies. Even in the presence of such mandates, the lack of strong evidence and recognized guidelines can lead to legal controversy. Payers have expressed concern that courts have routinely awarded coverage for TMD by health plans, despite exclusionary contract language and evidence that the insured patients have failed to disclose preexisting conditions or seek more conservative treatment first as required (Johnson 1997).

6. Summary of Cost Findings

A comparison of the total per patient costs drawn from the studies by Shimshak et al. (1997), Shimshak and DeFuria (1998), and White et al. (in press) yields a rough convergence. In the Shimshak et al. (1997) study of patients in a large northeastern health insurance plan during 1989-1990, the total annual per patient cost for TMD patients was $2,973 (current dollars), or 100% more than the non-TMD patients. In the Shimshak et al. (1998) study of patients in a large northeastern managed care organization during 1994, the total annual per patient cost for TMD patients was $2,773 (current dollars), or 93% more than the non-TMD patients. In the White et al. (in press) study of patients in a large northwestern HMO during 1990-1995, the total annual per patient cost for TMD patients was $2,661 (1995 dollars), or 57% more than the non-TMD patients.

As noted above, little or none of the costs of services provided by dentists was included in either of the Shimshak et al. (1997) or the Shimshak and DeFuria (1998) studies. The study by White et al. (in press) did account for costs of visits to a special TMD clinic as well as dental visits, which contributed 6.8% and 4.4%, respectively, to the differences in total average costs of the TMD cases and the non-TMD controls. Presumably, in the absence of the TMD clinic, a significant portion of the services provided there would have been absorbed by other types of outpatient, inpatient, or dental visits. Of course, there were certain differences in the criteria used to define TMD subjects in these studies, including the ICD-9-CM codes and, in the case of the White et al. study, the CPT codes and use of the TMD clinic in that study setting. The summary per patient cost figures are shown together in Table 8. Using the Medical Care Consumer Price Index (CPI), these figures are updated to 2000 dollars.

Table 8: Summary of Cost Data from Three Studies

Study	Base Year of Cost Data	Total Annual Per Patient Costs Base Year TMD	Non-TMD	Medical CPI Conversion Base Year–2000	Total Annual Per Patient Costs 2000 TMD	Non-TMD	Diff.
Shimshak et al.	1989-90	2,973	1,486	1.56	4,638	2,318	2,320
Shimshak and DeFuria	1994	2,773	1,440	1.23	3,411	1,771	1,640
White et al.	1995	2,661	1,696	1.18	3,140	2,001	1,139

Therefore, a rough approximation for total annual per patient costs for TMD patients is $3,100 - $4,700. A rough approximation for the difference between total annual per patient costs for TMD and non-TMD patients is $1,100 - $2,300. These estimates do not include out-of-pocket costs.

Rough estimates of the per patient costs of care associated with TMD-related services only, i.e., based on procedure and diagnosis codes generally recognized as being directly related to TMD,

may be inferred from the studies by Shimshak et al. (1997) and Shimshak and DeFuria (1998). As noted above, cost data reported by Shimshak et al. (1997) for the four ICD-9-CM codes used in that study to identify TMD patients can be annualized on a per capita basis, yielding an estimate of $133 per TMD patient per year, or $207 in 2000 dollars. Including the payments for claims for the additional 29 TMD-related codes increases that figure to $156 per TMD patient per year, or $243 in 2000 dollars. Similarly, using data from Shimshak and DeFuria (1998) for the 17 ICD-9-CM related specifically to TMD yields an estimate of $361 per TMD patient per year, or $444 in 2000 dollars. Of course, differences in the sets of codes used to identify TMD patients in these studies are among the multiple factors that likely contribute to differences in the cost estimates. While the estimates from these studies are of the same order of magnitude, they are small compared to the total health care costs generated by TMD patients, and small compared to the differences in total health care costs generated by TMD patients and non-TMD patients. While it does appear that the annualized costs and differences between TMD patient and non-TMD patient costs decrease with the more recent studies (including White et al. [in press]), these differences may be attributable to many factors other than any true cost trends. The few available studies on TMD-related health care costs that have been made available since 1996 do make clear that TMD patients use significantly more health care services than other patients, and that most of the cost of care provided for TMD patients is for diagnoses or conditions that are not known to be directly associated with TMD.

C. Ongoing Research

In considering the state of the TMD literature, it is useful to remain cognizant of ongoing studies that could make important contributions to the evidence base. Four additional ongoing studies relevant to TMD, including some identified by a search of the NLM's Clinicaltrials.gov database, are noted below. The latter three of these studies is still recruiting patients.

1. Alternative Treatments for TMD

A current RCT for which a report has not been published to date may offer further insights regarding the relative effectiveness of treatments for TMD with varying levels of invasiveness. Preliminary results of the trial, being conducted at the University of Minnesota, were presented by Dr. Eric L. Schiffman at the Temporomandibular Interagency Working Group Meeting held at the NIH/NIDCR on December 1, 2000 (Schiffman 2000, December). In this ongoing investigation, Schiffman et al. are studying 96 patients who were diagnosed with disc displacement without reduction, pain, and limited mouth opening. These patients were randomized into one of four treatment groups: medical management with standard pain medication (also including patient education, thermotherapy, rest, and monitoring), nonsurgical rehabilitation (including medical management plus orthodontics, dental visits, physical therapy, and health psychology), arthroscopic surgery (including nonsurgical rehabilitation), and disc repositioning surgery (including nonsurgical rehabilitation). There is no non-intervention control group included in this trial. Data are being collected at three-to-six month intervals with an objective measure of jaw function (mandibular movement and noise, using the Craniomandibular

Index [CI]) and a subjective perception of pain (using the Symptom Severity Index [SSI-JT]), and patients are being followed for five years.

Preliminary findings indicate that, after three months, all four groups improved relative to baseline for the CI and SSI-JT, but that there was no statistically significant difference among the groups. All patients have been in the study for at least two years, with more than half of all patients followed for at least five years, and the projected loss-to-follow-up rate is 15% at five years. To date, this study has had significant patient crossover, with approximately 40% of the study subjects crossing over from the medical management group to the nonsurgical intervention group during the course of the investigation. Also reported were preliminary estimates for direct costs of treatment, including medical management: $1,385; nonsurgical rehabilitation: $2,379; arthroscopic surgery: $7,890; and disc repositioning surgery: $13,128. These estimates were for costs to date for patients who had been enrolled in the trial for at least two years. Investigators suggest that five-year results will not be adequate for assessing the lifetime effectiveness of these treatments, and that a longer follow-up period is warranted. It is stressed that information shared at the December 2000 briefing was of an interim, preliminary nature only, and may not be consistent with the final results of this trial, which are not expected to be reported until 2003.

2. Study of Etanercept and Celecoxib to Treat Temporomandibular Disorders (Painful Joint Conditions)

This NIDCR-sponsored, two-part RCT will concurrently evaluate the effectiveness and side effects of two new anti-inflammatory drugs for relieving pain and improving jaw function in patients with TMD. Part 1 will evaluate celecoxib (Celebrex) and Part 2 will evaluate etanercept (Enbrel). Participants will complete written questionnaires about their jaw condition and will undergo a medical history, complete TMD evaluation, blood and urine tests, and radiographic and MRI studies of the TMJ. In both parts of the study, patients will be randomly assigned to either a treatment group or a placebo group. All patients will have a final evaluation six weeks after beginning treatment, including a TMD physical examination, and laboratory and x-ray tests as required. Pain diaries and questionnaires will be collected at the final visit. Decrease in pain, dysfunction, and improvement in quality of life will be assessed at base line and at the 6-week follow-up in the celecoxib study. In the etanercept study, individual outcomes, such as pain, mandibular range of motion, and an analysis of sample synovial fluid level of TNF (tissue necrosis factor) alpha will be assessed at baseline and at the six-week follow up.

3. Complementary Medicine Approaches to TMD Pain Management

This Phase II clinical trial, sponsored by the National Center for Complementary and Alternative Medicine (NCCAM), will evaluate whether selected complementary approaches to TMD pain management (i.e., acupuncture, chiropractic therapy, and bodywork therapy) delivered by complementary practitioners is as effective as usual TMD care provided by clinicians in a TMD clinic. Subjects will be evaluated at baseline, and six and 12 months post-intervention. Clinical examinations, saliva samples to assess salivary cortisol levels, and a series of questionnaires to

assess pain and grade of dysfunctional pain, psychological functioning, and other physical symptoms will be used to assess outcomes. The investigators will passively monitor health care utilization within Kaiser Permanente Northwest using clinical, research, and administrative databases. If these complementary interventions are shown to be effective, the goal is to design and implement a Phase III clinical trial to further evaluate the health consequences and cost of these therapies.

4. Alternative Medicine Approaches for Women with TMD

In another sponsored by the NCCAM, researchers are proposing to holistically address patient symptoms through three different approaches: naturopathic medicine (NM), traditional Chinese medicine (TCM), and usual care at Kaiser Permanente Northwest to better account for the multifactorial nature of TMD. The study will include a pilot test and Phase II trial to evaluate the two alternative healing approaches, TCM and NM delivered by TCM and NM practitioners, to compare the effectiveness of these approaches with usual TMD care provided by dental clinicians in a TMD Clinic. Subjects will be females with multiple health problems (defined as patients who have had at least four organ system-grouped diagnoses in the past year, not including TMD). Evaluations will be made at baseline, six, and 12 months after start of treatment. The primary endpoint will be change from baseline in the Axis II Pain Related Disability and Psychological Status Scale. Clinical examinations, saliva samples to assess salivary cortisol levels, and responses to a series of questionnaires to assess pain, chronic pain, psychosocial functioning, and other physical symptoms will be used to assess outcomes. The investigators will passively monitor health care utilization within Kaiser Permanente Northwest using clinical, research, and administrative databases to determine whether the interventions have an impact on overall health care utilization. To the extent that either of these alternative interventions is shown to merit a Phase III trial, the goal is to design and implement such a clinical trial to further evaluate the health consequences and costs of these alternative healing paradigms.

XII. DISCUSSION

TMD encompasses a variety of clinical disorders involving the TMJ, the muscles of mastication, and contiguous tissues. No clear consensus has emerged regarding the definition of TMD, its causes, how to diagnose it, most useful outcome measures, or how best to treat it. Multiple unrelated, underlying diseases can cause TMD symptoms, although no specific cause can be identified in many patients. Understanding of TMD etiology is complicated by multiple risk factors that are poorly documented or understood. The natural history of the condition is not well understood. TMD symptoms can increase and abate over time, and can resolve spontaneously without serious long-term effects.

The breadth of signs and symptoms of TMD and inconsistent information about TMD within the clinical communities often confounds diagnosis. Moreover, there is no widely accepted, standard test currently available to identify TMD. What diagnostic criteria that do exist are not well integrated into standard clinical practice. The ambiguity in TMD diagnosis contributes to

the use of a variety of diagnostic procedures and their attendant costs, as well as frustration for many patients.

Insufficient understanding of the etiology and course of TMD, along with insufficient diagnostic criteria, confound determination of effective treatments. Without adequate understanding of TMD, including its varying underlying causes in different subgroups of TMD patients, it is more difficult to demonstrate the effect of TMD interventions. To the extent that any treatment for a particular type or subgroup of TMD patients may be truly effective, measurement of its treatment effect in a clinical trial may be masked by the treatment's lack of effectiveness for other types of TMD patients included in such a trial.

Caring for TMD patients is further complicated by the range of clinicians involved in treating those afflicted with TMD. Selection of treatment appears to be associated with the type of provider consulted, underlining the lack of consensus regarding appropriate clinical expertise for managing TMD, and potentially facilitating vested interests among providers in particular treatments. In reference to a large portion of TMD patients, this is captured by Chase (2000), as follows.

> *What currently happens to patients seeking care for chronic TMD orofacial pain disorders? They become part of the diagnostic and treatment expertise of the general dentist, dental specialists, orofacial pain centers, and part of many other medical specialties, including both physician and nonphysician care. The care they receive is dependent on the health care door they walk through. The dentist may provide a splint, the chiropractor may provide manipulation, myofascial therapy, nutritional therapy, or even splint therapy. The neurologist will provide medications, the physical therapist will provide iontophoresis or other physical medicine modalities, otolaryngologists may provide splints or medication, massage therapists may provide deep tissue massage or cranio-sacral therapy, and the psychologist may provide biofeedback training, yoga training, or cognitive therapy. Any or all of these therapies may give the chronic pain patient a level of relief, and many of them are less expensive than care dispensed by dentists.*

A consequence of the uncertain and diverse clinical responsibility for TMD management, many patients endure extended searches for a definitive diagnosis and effective treatment, resulting in higher costs and exposing them to potentially adverse treatment effects.

The potential adverse effects of any treatment for TMD must be weighed against any relative benefits that it might confer relative to other TMD treatments, or to no treatment at all. Some treatments, including certain forms of the more invasive treatments, can result in greater pain, disfigurement, and other adverse effects. Given the lack of definitive evidence for the superiority of particular treatments for most TMD patients, more clinicians and researchers argue for employing conservative, reversible approaches to managing most patients with TMD, and progressing to increasingly more invasive ones only upon failure of the more conservative, reversible ones.

The body of evidence on the effectiveness of TMD treatment is generally limited and lacking in rigor. Our findings reinforce previous conclusions that few RCTs, particularly ones large enough to detect any true differences in outcomes among alternative treatments, or other types of rigorous studies exist for determining the effectiveness of treatments for TMD. The 45 studies that met our selection criteria exhibited a largely bi-modal distribution, including 15 RCTs and 20 single case studies/anecdotes. The design, implementation, and interpretation of clinical trials of TMD treatments is compromised by the absence of sufficient understanding of the etiology and course of TMD and diagnostic criteria that could be used for staging or other clinically meaningful distinctions among subgroups of TMD patients. Particularly lacking is evidence demonstrating relative differences in effectiveness among these treatments. Many of the existing clinical studies indicate that patients improve following treatment; however, few studies include non-intervention or placebo groups designed to control for such confounding phenomena as the placebo effect, regression to the mean, spontaneous abatement of symptoms, or cyclical expression of the disorder known to occur in TMD.

This current ambiguity in diagnosis and treatment of TMD patients is compounded by the fact that the literature in this area cannot be easily summarized, making it difficult to integrate findings from multiple studies. Many instances exist where a body of evidence on the effects of a health care intervention on certain diseases or conditions comprises conflicting findings or inconclusive findings due to studies having sample sizes that are too small for detecting true treatment effects. In these cases, it may be possible to integrate findings using meta-analysis or other integration approaches. However, these usually require having a group of studies involving a particular intervention used in populations with same or similar indications. The lack of clearly defined diagnostic criteria and well-defined interventions compromises efforts to integrate results from multiple studies or otherwise draw inferences about the effectiveness or cost of TMD treatments.

The potential discrepancy between the more "ideal" conditions in some RCTs and other investigations of TMD treatments conducted in research settings and the conditions of routine clinical settings in which most TMD is managed may diminish the validity of some of the available literature. This is recognized by researchers and was emphasized by certain of our clinician interviewees. RCTs conducted under ideal conditions and lacking sufficient duration may not add greatly to understanding "real-world" care, which often involve long-term treatment utilizing combinations of therapies and flexible pharmaceutical dosages. While this is a common debate in clinical research, it may be more relevant in this case due to the heterogeneous nature of TMD cases and treatments.

Our literature review confirms earlier efforts that there is a paucity of high-quality research available to eliminate some of the uncertainty surrounding diagnosis, treatment and measurement of outcomes for TMD patients. From an initial list of 840 articles identified related to TMD since 1996, only 45 studies were specific to treatment of TMD, and only five articles described the cost treating TMD. Of the 15 articles reporting evidence from RCTs of treatment for TMD, eight found significant improvements in pain and/or function from study initiation through follow-up. However, as noted above, most of these studies did not include a non-treatment control group, raising questions about the extent to which improvements could be attributed to

treatments. The largest type of literature published is classified as a single case study or anecdote, and the literature is diffuse in terms of modality explored. As a result, the literature on any one type or even group of interventions is limited, and it is difficult to draw well-founded conclusions about how well interventions for TMD work.

From the research on behavior modification and physical therapy, studies suggest that some types of interventions can be helpful in reducing pain and increasing function. Unfortunately, interventions studied range from a physical self-regulation to posture correction to an ambiguously described "cognitive therapy." The inclusion of long-term follow-up data, non-treatment comparison groups, and a comparison of the different methods of behavioral modification and physical therapy could improve the evidence on this category of treatment.

None of the published studies of pharmaceutical management for TMD identified since 1996 indicated significant, positive results.

Studies of occlusal therapy produced mixed results. Each of the four reports of RCTs involved a different occlusal appliance, thus complicating the ability to for consensus about a specific course of treatment. Overall occlusal therapy appears to have positive outcomes in the short term, though the improvement was not always statistically significantly different from the comparison group.

Two of the three RCTs that examined surgery as an option compared arthroscopy to arthrocentesis without including a non-treatment group. Both studies found improvement in pain and functioning and were not significantly different from each other, though arthroscopy may have better pain outcomes. The third RCT compared different arthroscopy techniques and found positive results over a one-year period. The non-RCT literature on surgery suggests that this option should be considered after other treatment methods have been attempted; in four of the 10 studies, patients had more pain and worse functioning following surgical intervention.

The useful recent literature on the cost of TMD is limited to a handful of retrospective studies, including two large case control studies and one large cohort study with a contemporaneous control group. Nevertheless, these are useful studies.

Using the findings of the studies as well as other determinations based on the results presented in them, a rough approximation for total annual per patient costs for TMD patients is $3,100 - $4,700. A rough approximation for the difference between total annual per patient costs for TMD and non-TMD patients is $1,100 - $2,300.

The limited literature on cost is consistent in two main ways. First, TMD patients use significantly more health care services and generate more costs than non-TMD patients. Second, perhaps contrary to expectation, most of the care used by TMD patients is not directly related to conditions generally recognized to be associated with TMD itself. Together, these observations lend further support to the observations that a significant portion of patients with TMD have other health problems, and that in many patients, TMD may itself be a symptom or other

manifestation of one or more other health problems associated with, e.g., the musculoskeletal system, digestive system, mental health, or nervous system.

Among the major findings of the recent report of the Surgeon General on oral health in America (U.S. Department of Health and Human Services 2000), there were two that were in particular accord with this study, excerpted as follows.

> *More information is needed to improve America's oral health and eliminate health disparities .... Health services research, which could provide much needed information on the cost, cost-effectiveness, and outcomes of treatment, is also sorely lacking ....*

> *Scientific research is key to further reduction in the burden of diseases and disorders that affect the face, mouth, and teeth. The science base for dental diseases is broad and provides a strong foundation for further improvements in prevention; for other craniofacial and oral health conditions the base has not yet reached the same level of maturity ....*

In the current era of evidence-based health care, the body of evidence on TMD treatment remains largely weak and unfocused. This contributes to ambiguity and variation in patient care for TMD. The limited data on per-patient costs of TMD make it difficult to assess the cost of managing the disorder and its broader economic impact. It is apparent that the additional health care costs generated by patients with TMD are for procedures and services that are not generally recognized as being directly related to TMD. The limited evidence on the efficacy/effectiveness of TMD treatment and per-patient costs likely contributes to reluctance of third-party payers to cover TMD treatment and variation in payment patterns among those that do provide coverage. There is growing recognition in the dental profession of the importance of evidence in guiding clinical and payment decisions (Marbach and Raphael 1997); however, this remains to be reflected sufficiently in the body of evidence pertaining to management of TMD.

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