Naval Submarine Medical Research Laboratory

Accuracy of a Computer Assisted Program for

"Classic" Presentations of Dental Pain

by

Karen FISHERKELLER, and Robert BEAUDRY, CAPT, DC, USN

Released by:

C. A. HARVEY, CAPT, MC, USN
Commanding Officer
NavSubMedRschLab

ACCURACY OF A COMPUTER ASSISTED PROGRAM FOR

"CLASSIC" PRESENTATIONS OF DENTAL PAIN

by

Karen FISHERKELLER and Robert BEAUDRY, CAPT, DC, USN

NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY

REPORT NO. 1136

Approved and Released by:

C. A. Harvey

C. A. HARVEY, CAPT, MC, USN
Commanding Officer
NavSubMedRschLab

Summary Page

PROBLEM:

To evaluate the accuracy of a computer-assisted dental program for "classic" presentations of trauma and non-trauma related dental pain.

FINDINGS:

The diagnostic accuracy of the dental program for "classic" dental cases was 78%. The program correctly distinguished between dental conditions requiring immediate evacuation and those which could reasonably be managed aboard submarines by independent duty corpsmen. Selection of the appropriate questionnaire to collect data was critical to the program's accuracy. The program was sensitive to minor variations in data entry, emphasizing the importance of accurate data.

APPLICATION:

Findings can assist in the development of a computer-assisted diagnostic program for dental pain for use by independent duty corpsmen at sea and serve as part of the basis for a recommendation for service use.

ABSTRACT

A computer-assisted dental program to assist independent duty corpsmen in the diagnosis and management of patients who present at sea with dental pain produced the correct diagnosis 78% of the time when given information considered by dentists to be "classic" for the condition in question. The program correctly distinguished between dental conditions which require immediate evacuation and those which can be managed aboard submarines by independent duty corpsmen.

INTRODUCTION

The computer-assisted program for dental pain was first developed at the Naval Dental Research Institute, Great Lakes, IL[1,2] and later adapted to MS-DOS format and implemented on an IBM-PC/AT by the Naval Submarine Medical Research Laboratory, Groton, CT. The program is rule based, designed for use with trauma and non-trauma related dental pain, and considers a total of 35 dental conditions in its evaluation of patients with dental pain.

Nine questionnaires were developed to evaluate real-time entry of patient data into the program. One questionnaire is used for trauma related conditions and the remaining eight questionnaires are for non-trauma related dental conditions. Table 1 lists the eight categories of non-trauma related dental conditions. Based on an initial evaluation of the patient, the user selects the questionnaire most appropriate for the presenting dental problem. Each questionnaire consists of a list of questions and branch points. The questions cover subjective and objective findings, and the branch points direct the examiner to gather further information depending on the responses to previous questions. The branch points reflect the logic of the diagnostic program. If the examiner follows the directions of the branches, he will collect only the information required by the program for a diagnosis.

Table 1. Eight questionnaires used to collect information for the diagnosis of non-trauma related dental pain.

> Tooth Specific
> Teeth, Generalized/Multiple
> Gingiva, Specific Area
> Gingiva, Generalized Area
> Oral Mucosa, Tooth Associated
> Temporomandibular Joint/Muscle
> Dental Extraction Site
> Tissue Swelling

After interviewing the patient and recording findings on the dental questionnaire, the corpsman enters the data into the diagnostic program. Upon completion of data entry, the computer-assisted dental program evaluates symptom findings against a set of diagnostic rules and makes a diagnosis when, and if, the conditions of a rule are met. Sometimes the program cannot reach a diagnosis based on the information and displays a statment to that effect. The program provides both "possible" and "probable" dental diagnoses and treatment information. The 35 dental conditions considered by the program are listed in Table 2. Note that many of the diagnoses are not mutually exclusive and may be present simultaneously. Some of the diagnoses are quite evident on examination, but were included to provide the hospital corpsman with confirmation of his own diagnosis and rapid access to related treatment information.

The dental program is designed for use by independent duty corpsmen aboard submarines in their management of dental pain at sea. Before the program can be implemented in an operational setting, however, its accuracy needs to be evaluated. This paper reports on the results of two studies which examine the accuracy of the computer-assisted program with regard to "classic" presentations of trauma and non-trauma related dental pain.

Table 2. Thirty-five dental conditions considered by the computer-assisted progam for the diagnosis of trauma and non-trauma related dental pain.

Abscess/infection/cellulitis	Fractured mandible
Acute apical abscess	Fractured maxilla
Acute apical periodontitis	Fractured facial bones
Acute herpetic gingivostomatitis	Irreversible pulpitis
Acute gingivitis	Internal derangement of the TMJ
Carious lesion (decay)	Localized alveolar osteitis
Dentin hypersensitivity	Maxillary sinusitis
Defective restoration	Myofascial pain/muscle spasms
Displace/mobility of tooth, favorable prognosis	Necrotizing ulcerative gingivitis
Displace/mobility of tooth, guarded prognosis	Neurologic injury
Endo/perio combined problem	Osseous sequestrum
Enamel fracture	Occlusal trauma
Food impaction	Periodontal abscess
Fractured crown, small pulp exposure	Periocoronitis/erupting tooth
Fractured crown, large pulp exposure	Reversible pulpitis
Fractured crown, pulp not exposed	Root fracture
Fractured alveolar bone	Total avulsion, good candidate for replant
	Total avulsion, poor candidate for replant

STUDY ONE

Method

Nineteen dentists at the Naval Submarine Base Branch Dental Clinic, Groton, CT participated in the first study. Using the questionnaires, each dentist provided "classic" responses expected from interviewing and examining patients with several of the 35 dental conditions. Diagnoses were assigned to dentists so that each dentist provided information for three or four different conditions. Altogether, two sets of "classic" responses were gathered for each condition except for Abscess/Infection/Cellulitis, for which only one was obtained. Dentists provided cases only for conditions in their specialty and the two scenarios for a given illness were completed by different dentists.

The symptoms for each of the resulting 69 "classic" cases were entered independently into the computer-assisted diagnosis program by three research investigators. After the data for a

case have been entered, the program evaluates the symptom information against a set of diagnostic rules and, if the conditions of a rule are met, makes a diagnosis. The program also classifies the diagnosis as either possible or probable. Sometimes the program cannot reach a diagnosis; in these cases, a statement to that effect is displayed. The program may arrive at several possible diagnoses for a given set of symptoms. Often the several diagnoses describe related aspects of the same condition. The diagnoses made by the computer for each of the 69 "classic" cases were recorded. The computer program was considered to be accurate if one of the diagnoses made by the program as either probable or possible was identical to the diagnosis for which the "classic" findings had been supplied.

Results

Table 3. Dental conditions classified according to the program's accuracy for both, one or neither "classic" presentation.

<u>Dental conditions for which the program produced a correct diagnosis for both "classic" presentations.</u>

Acute apical abscess	Fractured mandible
Acute apical periodontitis	Fractured maxilla
Acute gingivitis	Fractured facial bones
Carious lesion (decay)	Irreversible pulpitis
Dentin hypersensitivity	Internal derangement of the TMJ
Defective restoration	Localized alveolar osteitis
Displace/mobility of tooth, favorable prognosis	Necrotizing ulcerative gingivitis
Displace/mobility of tooth, guarded prognosis	Osseous sequestrum
Enamel fracture	Periodontal abscess
Fractured crown, pulp not exposed	Periocoronitis/erupting tooth
Fractured alveolar bone	Total avulsion, good for replant
	Total avulsion, poor for replant

<u>Dental conditions for which the program produced a correct diagnosis for one of two "classic" presentations.</u>

Acute herpetic gingivostomatitis	Neurologic injury
Food impaction	Osseous sequestrum
Fractured crown, small pulp exposure	Reversible pulpitis
Maxillary sinusitis	Root fracture

<u>Dental conditions for which the program failed to produce a correct diagnosis for either of the "classic" presentations.</u>

Abscess/infection/cellulitis*	Myofascial pain/muscle spasms
Endo/perio combined problem	Reversible pulpitis

*For Abscess/infection/cellulitis, only one "classic" presentation was entered, and the computer misdiagnosed the presentation.

The diagnostic program for trauma and non-trauma related dental pain arrived at the correct diagnosis for 54 of the 69 "classic" cases (78% accuracy). The program accurately diagnosed both "classic" case scenarios for 23 of the 35 diagnoses considered by the program. Dental conditions for which the computer was accurate for both, one or neither case presentation are presented in Table 3.

The program listed only a single diagnosis for 30 of the 69 case presentations (43%). Of these 30 diagnoses, 24 (80%) were correct. It displayed two diagnoses for 16 cases (23%), of which 10 (63%) were correct. And it displayed three to seven diagnoses for the remaining 23 cases (33%), among which the correct diagnosis was included in 20 cases (87%).

The program misdiagnosed 15 "classic" cases. First, the program was unable to arrive at a diagnosis for case presentations of Maxillary sinusitis and Myofascial pain/muscle spasm. Second, the program misdiagnosed both cases of Endodontic/periodontic combined problem, Myofascial pain/muscle spasm, Fractured crown-large pulp exposure, and the sole case of Abscess/infection/cellulitis. Last, the program misdiagnosed one of the two presentations of Reversible pulpitis, Maxillary sinusitis, Acute herpetic gingivostomatitis, Food impaction, Occlusal trauma, Fractured crown-large pulp exposure, Root fracture and Neurologic injury.

While diagnostic precision of any computer-assisted diagnostic aid is desirable, the therapeutic accuracy of the program has greater functional importance to independent duty corpsmen at sea. With this in mind, each dental condition was classified according to one of three kinds of therapeutic interventions available at sea. These are: evacuate immediately; treat aboard - potential for condition to warrant evacuation; and treat aboard - return to duty. Dental conditions such as fractured mandible, fractured maxilla, and fractured facial bones require immediate evacuation. The other dental conditions are treated aboard and the individual returned to duty, or treated aboard with the potential for evacuation. The program was completely reliable in that it never suggested immediate evacuation for conditions where the usual treatment is returning to duty. In addition, the program never suggested returning to duty for conditions requiring immediate evacuation.

Discussion

The program produced an accurate diagnosis for 78% of these "classic" trauma and non-trauma related dental cases. When accuracy was examined according to treatment rather than diagnostic precision, the program reliably distinguished between dental conditions requiring immediate evacuation and those for which treatment is returning to duty.

The program made more than one diagnosis for most of the cases. In general the other diagnoses which accompanied the "correct" diagnosis were closely related, often causal, to the dental condition for which a dentist had supplied the findings. Since the program should be most accurate for "classic" case presentations, diagnostic accuracy might be less for real cases where the symptoms are not so clear cut. In addition, the diagnostic program completely misdiagnosed 15 case presentations. An examination of the diagnostic rules for each of these cases showed that three cases were misdiagnosed because the wrong questionnaire was selected to record the symptoms. For example, in order to arrive at a diagnosis of Myofascial pain/muscle spasm, the user must complete the questionaire for dental injuries to the Temporomandibular Joint/Muscle; instead, the questionnaire for Tooth Specific dental injuries

was used, precluding the correct diagnosis. On the remaining 12 misdiagnosed cases, a change in the response to one question for 11 of the cases and to two questions for the other case would have resulted in a correct diagnosis. These findings indicate how unforgiving the program can be to small variations in symptomology and failing to use the appropriate questionnaire to interview the patient.

STUDY TWO

The first study left a number of unanswered questions. First, were the findings of the case truly "classic" to the particular dental diagnoses? Second, in the case of multiple diagnoses, were the diagnoses reasonable in consideration of the findings for the case? And third, should the program have considered any other diagnoses based on the findings provided for the case? To answer these questions, a second study was conducted.

Method

The findings required by the computer to make a diagnosis for each of the case presentations in the first study were recorded on dental questionnaires. These findings were not always the same as the ones provided by the dentist as "classic" to a diagnosis. However, when the branching of the questionnaire was carefully followed, the "classic" findings provided by the dentist and those required by the computer program were the same.

Questionnaires were distributed to the 19 dentists who participated in the first study. Each dentist was asked to review the findings for three or four cases. No dentist reviewed a case for which he had originally supplied the findings. The dentists were also given the list of diagnoses generated by the computer for each case they reviewed as well as the expected diagnosis. After reviewing the case, the dentist responded to three questions. First, were each of the diagnoses made by the computer for the case reasonable in consideration of the patient information previously provided by another dentist? Second, were the findings of the case "classic" to the particular diagnosis. And third, were there other diagnoses the computer should have considered, but failed to consider?

Results

On 40 of the 69 cases (72%), the dentists reported that all of the diagnoses made by the computer program for the case were reasonable in consideration of the findings provided. In addition, the dentists considered the findings to be "classic" for 46 of the 69 cases (67%). It is interesting that of the 15 cases misdiagnosed by the computer, the dentists considered only two (13%) to be "classic" presentations of the disease, but for the 54 cases correctly diagnosed by the computer, the dentists considered 44 of the cases (81%) to be "classic". And while the dentists considered most of the cases to be "classic", they also felt that the computer program should have considered additional diagnoses for a little more than a third of the cases (36%).

Discussion

The second study helped to answer a number of questions posed by the results of the original study. The computer-assisted dental program arrived at multiple diagnoses for many of the cases, even though the findings provided were supposed to be "classic" to a particular diagnosis. The subsequent study showed that for most of the cases (72%), the dentists found the alternate diagnoses reasonable in consideration of the findings. This probably is because the program exhaustively lists all diagnoses which are suggested by the findings, which tends to include related and often causal conditions underlying the single "classic" diagnosis for which findings were provided. In fact, the dentists occasionally felt that the program failed to consider all the possible diagnoses. It is interesting that the dentists found the findings "classic" for 81% of the cases accurately diagnosed by the dental program, but only 13% of the misdiagnosed cases. Perhaps it is not as easy as first thought to identify "classic" findings for certain dental conditions and, even though the findings for a case may be "classic", it is not possible to exclude all but a single diagnosis.

Summary

These two studies evaluated the accuracy of the computer-assisted dental program for "classic" presentations of trauma and non-trauma related dental pain. The overall diagnostic accuracy of the program was found to be 78%. More importantly, the program correctly distinguished between dental conditions requiring immediate evacuation and those for which treatment is provided aboard and the individual is returned to duty. The program was not as accurate for cases where findings were not clearly "classic". While the program arrived at multiple diagnoses for many of the cases, the dentists reported, most of the time, that the alternate diagnoses were reasonable in consideration of the findings. Three cases were misdiagnosed as a direct result of the wrong questionnaire being selected to record information, demonstrating that use of the appropriate questionnaire is critical to the program's accuracy and suggesting a need for the program to guide the user in the selection of a questionnaire. Data collected in an initial evaluation of the patient (e.g. location and type of pain) could be used by the program to select the appropriate questionnaire for conducting the patient interview. Minor variations in responding to the program's questions had significant effects on the diagnoses made by the program. This finding emphasizes the importance of good data collection to program accuracy. Before the dental program can be used by Navy hospital corpsman in an operational setting, it is important to show that corpsmen possess the ability to select the appropriate dental questionnaire to use in interviewing dental patients and the skills necessary to collect accurate data.

REFERENCES

1. Ralls, S.A., Southard, T.E., & Cohen, M.E. A System For Computer-Assisted Dental Emergency Diagnosis. Military Medicine, 151, 12:639, 1986.

2. Ralls, S.S., Cohen, M.E., Southard, T.E. Computer-Assisted Dental Diagnosis. Computer Applications in Dentistry. Dental Clinics of North America, Vol. 30, No. 4, Oct. 1986.

ACKNOWLEDGMENTS

REPORT DOCUMENTATION PAGE		Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE				
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NSMRL Report 1136		5. MONITORING ORGANIZATION REPORT NUMBER(S) NA		
6a. NAME OF PERFORMING ORGANIZATION Naval Submarine Medical Research Laboratory	6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION Naval Medical Research and Development Command		
6c. ADDRESS (City, State, and ZIP Code) Naval Submarine Base New London Groton, CT 06349-5900		7b. ADDRESS (City, State, and ZIP Code) NMC NCR, Bethesda, MD 20814-5044		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Same as 7a	8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State, and ZIP Code) Same as 7b		10. SOURCE OF FUNDING NUMBERS		

10. SOURCE OF FUNDING NUMBERS			
PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
62233N	MM33C30	002	5004

11. TITLE (Include Security Classification)
(U) Accuracy of a computer assisted program for "classic" presentations of dental pain

12. PERSONAL AUTHOR(S)
Karen Fisherkeller and Robert Beaudry

13a. TYPE OF REPORT Interim	13b. TIME COVERED FROM 10/88 TO 3/89	14. DATE OF REPORT (Year, Month, Day) 11 April 1989	15. PAGE COUNT 8

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	dental; computer assisted diagnosis; validity

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

A computer-assisted dental program has been developed by the Naval Dental Research Institute, Great Lakes, Illinois and the Naval Submarine Medical Research Laboratory, Groton, Connecticut to assist independent duty corpsmen in the diagnosis and management of patients who present at sea with dental pain. The diagnostic program is rule based, designed for use with trauma and non-trauma related dental pain, and considers a total of 35 dental conditions. Nine questionnaires are used to collect information from the patient. One questionnaire is used for trauma related dental pain, and the remaining eight questionnaires are for non-trauma related dental pain. The questionnaires can be used in lieu of real-time data entry to gather information about a patient which the computer program requires. Dental findings are entered into the program and are evaluated by a set of diagnostic rules. The program makes a diagnosis when, and if, the conditions of a rule are met. This paper reports on the accuracy of the computer based dental program for "classic" presentations of dental pain.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL Susan D. Monty, Publications Office	22b. TELEPHONE (Include Area Code) (203) 449-3967	22c. OFFICE SYMBOL 421

DD Form 1473, JUN 86   Previous editions are obsolete.   SECURITY CLASSIFICATION OF THIS PAGE

S/N 0102-LF-014-6603   UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

19 Cont'd

Questionnaires were distributed to 19 dentists. The dentists used the
questionnaires to record "classic" findings for each of the 35 dental conditions
considered by the program. When these presentations were entered into the computer
program, its diagnostic accuracy was 78%. More importantly, the program correctly
distinguished between dental conditions which warrant immediate evacuation and those
which can reasonably be managed aboard submarines by independent duty corpsmen.
Accurate diagnosis by the program was dependent on user selection of the appropriate
questionnaire to record patient data. In addition, the program was sensitive to
minor variations in data entry, emphasizing the importance of accurate data.