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Dental Epidemiology of Military Operations

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In this paper we review studies that have been conducted on the epidemiology of oral, dental, and maxillofacial conditions during military deployments. The limitations of our current knowledge base are discussed, as is a proposed research effort to enhance the responsiveness of dental support in theaters of operation.

Introduction

Epidemiologic data on the occurrence, preventability, and treatment of oral, dental, and maxillofacial conditions during military operations are sparse. Experience during Operation Desert Shield/Storm (ODS) illustrated that the Army Dental Corps needs a better system to gather data needed for operational planning and management of dental services and for identifying deficiencies in dental material in a theater of operations. The purpose of this paper is to identify the type of data required to address these shortcomings and to propose steps to acquire this data.

Background

According to Army Field Manual 8-10-19, delivery of dental care is classified into a four-level hierarchy: emergency care, sustaining care, maintaining care, and comprehensive care. Higher levels of care incorporate services provided at lower levels. Within a theater of operations, only the lower three levels of care are available, with the level dependent on the tactical and strategic situation.¹ A description of these three levels as found in FM 8-10-19 follows.

Emergency care is the most basic type of care. It consists of services rendered to relieve oral pain, to eliminate acute oral infections, to control life-threatening oral conditions (hemorrhage, cellulitis, or respiratory distress), and to treat trauma to the teeth, jaws, and associated facial structures. Common ex-

amples of emergency care include simple extractions, temporary fillings, and prescriptions. Emergency care should be available throughout a theater of operations.

Sustaining care refers to treatment directed toward intercepting potential dental emergencies in order to minimize time lost to troops engaged in medium- to high-intensity operations. It focuses on soldiers in dental fitness class 3. Common examples of sustaining care include basic restorations, extractions, pulpectomies, simple prosthetic repairs, and treatment of acute periodontal conditions. Sustaining care should be available in forward treatment sections of area support dental units and in dental sections of forward support companies.

Maintaining care seeks to maintain the overall fitness of soldiers at a level consistent with combat readiness. Here the focus is broadened to include soldiers in dental fitness class 2. Maintaining care covers restorative, oral surgical, periodontal, endodontic, prosthetic, and preventive services.

Comprehensive care includes the full range of dental services. It is not provided in a theater of military operations.

Literature Review

In our review of the literature, we could identify seven studies that exclusively addressed dental emergencies²⁻⁸ and four that exclusively addressed maxillofacial injuries⁹⁻¹² among deployed military personnel. A book written on dental care in World War II (WWII)¹³ and the most recently published article on military dental care in a deployed setting¹⁴ focused on total dental services provided. Neither of the latter two sources distinguished routine from emergency care. The WWII treatise did separate out maxillofacial injuries, but the more recent study did not.

No single study addressed all of these topics concurrently. Because one report⁸ provides an excellent detailed review of previous studies on dental emergencies and maxillofacial injuries, we choose here to focus on identifying specific deficiencies in the available literature. Readers who prefer more detail are encouraged to consult *Theater of Operations Dental Workload Estimation* by King and Brunner.⁸

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Dental Emergencies

Table I shows the scope of topics explored in studies of dental emergencies among deployed military personnel. No two studies were identical in content. Only two topics—rate of dental emergencies and distribution of cause of dental emergencies—were shared in common by all studies.

Even where similar topics were covered, comparisons between studies are problematic because of differences in the range of responses used in collecting the data. For example, for "cause of dental emergencies," the number of responses ranged from a minimum of seven⁶ to a maximum of thirty.⁸ During analysis, responses were combined together to define categories of the outcome variable. The category "caries" for the outcome variable "cause of dental emergencies" was defined differently across the seven studies. Some investigators grouped periapical abscesses, decay, and defective fillings as caries;^{3,4} one grouped decay and defective fillings as caries but kept periapical abscesses as a separate category;² another grouped decay and periapical abscesses as caries but combined defective fillings with tooth fractures;⁶ and finally, some investigators listed each condition separately.^{5,7,8}

The impact of using different definitions for caries during analysis is illustrated in Table II. The column "percent due to caries" represents what each investigator reported as caries. The adjacent column—"adjusted percent due to caries"—defines caries to include decay, periapical abscesses, and defective restorations. The results show that in all studies caries was the leading cause of dental emergencies. However, when a common definition of caries is applied, the range and variation of caries prevalence across the studies narrows considerably.

In addition, Table II highlights key differences across these studies aside from content. Half were conducted a decade ago.⁵⁻⁸ The other half are over two decades old.²⁻⁴ Thus, the earlier studies were conducted on a conscript Army, the latter on an all-volunteer force. Data collection ranged from 10 days to 6 months and was done in diverse settings (field training exercises, non-combat deployments, and combat zones). The population studied was highly variable (from 602 to 64,167) as was the number of cases of dental emergencies reported (from 39 to 3,377).

There is one additional important difference Table II does not show. The Teweles and King study is distinct from the others in that, prior to deployment, "an intensive program was conducted to improve the dental health of the troops being deployed."⁷ The goal of this preparation was to lower the dental emergency rate. Compared to contemporary studies,⁵⁻⁸ the dental emergency rate and caries prevalence in the Teweles and King study are lower.

Results from the dental emergency studies show dental emergency rates (i.e., the number of dental emergencies per 1,000 troops per year) as low as 65.8 and as high as 259. Curiously, the two studies based in Vietnam^{2,3} reported vastly different dental emergency rates. As mentioned above, a consistent finding across all studies was that dental caries is the leading cause of dental emergencies among deployed troops.

Another finding that was fairly consistent across the four studies in which it was reported was the leading treatments provided. In three of four studies, prescriptions were the most common treatment, accounting for one-quarter to one-third of all treatments. (Prescriptions may well have been the leading treatment in all four studies if Payne and Posey had included prescriptions in their tally of treatments rendered.) The second most common treatment in all four studies was extractions. They accounted for about one-fifth of all treatments.

Maxillofacial Injuries

Table III lists the studies which looked at maxillofacial injuries in deployed military personnel. One study dates back to WWII,¹³ one to the Korean War,⁹ and the other three are from the Vietnam War.¹⁰⁻¹² For the most part, these articles were case studies of surgical management which contained little useful epidemiologic data. In three of the four more recent studies, although the number of cases treated were enumerated, it was not clear what proportion of total theater maxillofacial casualties they represented. Moreover, the size of the population from which they were drawn was not given, so it is impossible to calculate an incidence rate.⁹⁻¹¹ In the data presented by Jeffcott¹³ and by Tinder et al.,¹¹ the samples include some non-U.S. Army personnel.

Using data from a long-term study that the Navy conducted

TABLE I
RESEARCH TOPICS PROBED ON STUDIES OF DENTAL EMERGENCIES OF DEPLOYED MILITARY PERSONNEL

Investigator(s)	Research Topics										
	A	B	C	D	E	F	G	H	I	J	K
Sumnicht	X	X		X		X		X			
Hutchins and Barton	X	X	X	X							
Ludwick and Gendron	X		X	X						X	
Payne and Posey	X			X		X			X		X
Parker, King, and Brunner	X			X	X	X	X				X
Teweles and King	X		X	X							X
King and Brunner	X		X	X		X	X				X

Code for Research Topics: A = rate of dental emergencies; B = percent of dental emergencies that are valid as judged by examining dentist; C = temporal distribution of dental emergencies; D = distribution of cause of dental emergencies; E = impact of compliance with Army Oral Health Maintenance Program on dental emergencies; F = distribution of rank of dental emergency care seekers; G = disposition after dental emergency care treatment; H = distribution of distance traveled for emergency dental care; I = estimated lost duty time due to emergency dental care; J = distribution of mode of travel for emergency dental care; K = distribution of emergency dental care treatments received.

TABLE II
COMPARISON OF STUDIES OF DENTAL EMERGENCIES OF DEPLOYED MILITARY PERSONNEL

Investigator(s)	Year	Setting	Duration	No. of Cases	Population	Dental Emergency Rate ^a	Percent Due to Caries ^b	Adjusted Percent Due to Caries ^c	Primary Treatment	Secondary Treatment
Sumnicht	1964	FTX (NV, AZ, CA)	19 weeks	1,453	25,714 (avg)	152	33%	47%	—	—
Hutchins and Barton	1967	Vietnam	10 months	3,377	Not given ^d	65.8–99.1	60%	60%	—	—
Ludwick and Gendron	1969	Vietnam	3 months	3,370	64,167 (avg)	210	50.9%	50.9%	—	—
	1970	Vietnam	6 months	2,398	30,533 (avg)	157.2	48.9%	48.9%	—	—
	1970	CONUS	6 months	3,057	25,431 (avg)	240	46%	46%	—	—
Payne and Posey	1981	FTX (NY, CA)	39 days	438	Not given	167.4	38.6%	52.2%	Temporary rest 33.1%	Extraction 20.4%
Parker, King and Brunner	1981	FTX (CA)	117 days	92	7,745	234	41.2%	52.2%	Prescription 35.4%	Extraction 20.9%
Teweles and King	1982	Sinai, Egypt ^e	5 months	39	602	160	20.5%	40.9%	Prescription 31.3%	Extraction 20.9%
King and Brunner	1982	FTX (Europe)	10 days	355	49,902	259	48%	52.5%	Prescription 25.5%	Extraction 17.3%

^aPer 1,000 troops per year.

^bIn all studies, caries was the leading cause of dental emergencies. The figure represents what the investigators classified as caries.

^cAdjusted caries percent includes decay, periapical abscesses, and defective restorations.

^dNot stated for security reasons.

^eA non-combat deployment.

TABLE III
COMPARISON OF STUDIES OF MAXILLOFACIAL INJURIES OF DEPLOYED MILITARY PERSONNEL

Investigator(s)	Year	Setting	Duration	No. of Cases	Population	Rate ^a	Percent Due to Hostile Action	Percent Hostile Wounds Due to Missiles	Percent Missile Wounds Due to Bullets
Jeffcott	1941–1945	WWII CONUS	4 years	—	—	0.6–1.2 ^b	—	—	—
	1941–1945	WWII OCONUS	4 years	—	—	0–3 ^c	—	—	—
Chipps, Canhan, and Makel	1950–1953	Korea ^d	31 months	1,000	—	—	70%	67.9%	—
Terry	1966–1967	Vietnam ^e	1 year	110	—	—	79%	80%	38%
Tinder, Osbon, Lilly, Salem, and Cutcher	1967–1968	Vietnam ^f	1 year	4,089 ^g	—	—	68.4%	96%	14.8%

^aPer 1,000 troops per year.

^bMinimum and maximum rates over 4-year period.

^cMinimum and maximum rates over 4-year period.

^dCases treated at Army hospitals in Japan. As the war progressed, more cases were treated in Korea.

^eCases treated on a Navy hospital ship.

^fCases treated at selected Army hospitals in Vietnam.

^g84.4% of cases were U.S. Army personnel. The remainder included other U.S. military personnel as well as U.S. and foreign military and civilian personnel.

during Vietnam primarily to follow the length of time it took to rehabilitate maxillofacial injuries, Kelly estimated that 12% of U.S. troops in Vietnam sustained war-related injuries. Citing the work of Tinder et al.,¹¹ Kelly attributed 10 to 15% of all war injuries in Vietnam to maxillofacial casualties.¹²

The WWII study¹³ was the only one to provide incidence data. Jeffcott actually presented these data in graphical form on a monthly time line. He presented different graphs for mandibular and maxillary fractures. Distinct plots were made for continental U.S. (CONUS) troops, overseas troops, and all

troops combined. In order to simplify tabular presentation of his data, Table III combines Jeffcott's mandibular and maxillary fracture rates over time and presents the minimum and maximum annual values over the 4-year period.

Jeffcott's original method of presenting his data has the advantage of illustrating time trends in the data. Fracture rates varied considerably over the course of the war. In 1942, the fracture rates were higher in CONUS personnel; however, from 1943 to 1945, fracture rates overseas surpassed the CONUS rate. Near the end of 1945, fracture rates for both categories of personnel converged. One might infer that these fluctuations correlated with the intensity of the conflict.

Jeffcott¹³ did not classify the cause of maxillofacial injuries. Results from the non-WWII studies show that about 70 to 80% of maxillofacial injuries were due to hostile action. The proportion of wounds resulting from hostile action that were due to missiles varied widely. Fewer such injuries occurred in Korea than in Vietnam. The proportion of missile wounds due to bullets was low in the non-WWII studies. The majority were due to fragments or other missiles.⁹⁻¹²

Total Dental Services

In addition to maxillofacial injuries, Jeffcott reported incidence rates for three other dental conditions—cellulitis, osteomyelitis, and Vincent's stomatitis. He also reported counts of seven dental procedures completed—permanent fillings, complete dentures, partial dentures, extractions, denture repairs, fixed bridges, and oral prophylaxes. In all cases, Jeffcott reported figures for CONUS, overseas, and total personnel as raw counts and as number per 1,000 troops mean strength per year. Among personnel deployed overseas, the most common treatment rendered was permanent fillings. The rate for permanent fillings fluctuated somewhat over the 4-year period and averaged 1,290 per 1,000 troops per year. For CONUS-based troops, permanent fillings were the most common treatment and averaged 4,000 per 1,000 troops per year.¹³ Clearly, in WWII, less dental care was provided in the theater of operations than in CONUS.

For Operation Desert Shield/Storm (1990–1991), King calculated the rate for dental services overall on a monthly basis. The rate fluctuated from 217 per 1,000 troops per year to 713 per 1,000 troops per year. The two highest incidence rates occurred in the month immediately preceding and the month immediately succeeding the ground war.¹⁴ Data from the pre-war build-up suggest that sustaining or maintaining care generated a significant level of demand for dental care.

Regarding mix of dental services provided, King found that gingival or periodontal conditions were the leading cause of dental visits overall.¹⁴ However, he did not track the conditions over time to determine if there were any time trends in the data.

Requirement for New Dental Data

In *Theater of Operations Dental Workload Estimation*, King and Brunner argue that data on the incidence of dental emergencies and maxillofacial injuries and on the prevalence of case and treatment mix should be collected routinely during military deployments. Such data are vital to dental corps leadership for operational planning for future deployments as well

as for monitoring the adequacy of dental support during ongoing deployments. As King and Brunner remark: "The emphasis on accountability and the requirement to justify planned resources bring sharply into focus the need to improve record keeping of an appropriate quantity and quality."⁸

As part of their study, King and Brunner proposed a computer simulation model to estimate dental manpower and resources needed during a deployment. This model underwent further development and eventually evolved into the Triservice Panel For Standardization of Dental Workload Requirements (TPSDWR) model.¹⁵ The data used in the TPSDWR model was derived from subject matter expert opinions and extrapolation from very limited documented data on the occurrence of dental conditions during past deployments. TPSDWR organizes the prevalence of dental conditions around three groups: dental emergencies, conditions requiring sustaining/maintaining care, and maxillofacial conditions.

In order to improve the predictions that the TPSDWR model makes, it is essential to update our epidemiologic knowledge base about the incidence of dental emergencies and maxillofacial injuries and the prevalence of dental conditions and their treatments during military deployments. Existing data bases are antiquated. All are at least 10 years old and therefore do not reflect current trends in dental disease or in military demographics. These trends have been rather dramatic and may have had a significant impact on the prevalence of dental disease in the military population.

For instance, over the past decade, the National Institute for Dental Research documented a 36% decline in caries among 5- to 17-year-old children in the United States.¹⁶ Over the same period, a major shift in the educational qualifications of incoming Army recruits occurred. In 1979, roughly half of enlisted recruits scored in Category IV on the Armed Forces Qualification Test (AFQT), a level so low as to be considered untrainable. Current figures show less than 1% have AFQT scores in Category IV.¹⁷ Both of these trends may contribute to lowering rates of dental conditions requiring treatment (especially preventable ones such as dental caries) among deployed military personnel.

As mentioned above, aside from predicting resource needs, we also need systematic reporting of dental emergencies and maxillofacial injuries in order to monitor the adequacy of dental support during an ongoing major deployment. Despite our best attempts at predicting dental manpower and resource requirements, unforeseen factors and circumstances may radically change those requirements. Obviously, an armed conflict has the potential for greater and more serious casualties than a field training exercise. Also, length and intensity of the conflict, type of weapons used by opposing forces, remoteness of the conflict, as well as weather and terrain may influence the incidence and mix of casualties. Data from ODS suggest that component mix of our forces is another factor that influences the level of dental support needed during a deployment. Reserve component soldiers constituted a large fraction of ODS forces and had a markedly higher prevalence of Dental Fitness Class 3 conditions than active duty soldiers.¹⁴ However, because no system was in place to collect data on dental emergency and maxillofacial injury rates during ODS, we do not know the extent to which force mix contributed to utilization of dental services.

Conclusion and Future Research

This paper has identified the need to better document the contribution of dental support in military operations. It proposes development of a patient encounter form that can be used in future military operations to collect data on routine dental, dental emergency, and maxillofacial injury rates and treatments in deployed populations. This will assist Dental Corps leadership in meeting a key management objective of the Dental Combat Effectiveness Program (DCEP).¹⁸ Successful implementation of the DCEP is dependent on accurate data on the incidence and mix of emergency dental services provided during military operations. Feedback is essential for Dental Corps leadership to determine whether the number and mix of care providers assigned to support a major deployment is adequate. Aside from providing a useful tool for collecting management-related indicators, a thoughtfully designed patient-encounter form will enable collection of valuable epidemiologic data of dental conditions and treatments during military operations. Data on the epidemiology of military dental conditions will assist in identifying capability issues that can be corrected by doctrine, training, materiel, or research efforts.

At present, the Epidemiology Section of U.S. Army Institute of Dental Research is developing a field dental-encounter form which will be tested in a variety of deployed settings. The ultimate goal of this research is to develop a data-collection instrument that will be used in all future deployments.

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