Sports Dentistry and the Olympic Games

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Abstract

This paper will provide a review of dental services from previous Olympic Games, and will outline components of an ideal dental program for future event organizers.

The Olympic Games bring the finest amateur and professional athletes in the world together for competitions every four years. The games are awarded by the International Olympic Committee to a host city, which in turn creates an Organizing Committee responsible for all aspects of the games, including the development of an appropriate medical service. Under the direction of the IOC Medical Commission, and in accordance with the stipulations of the Olympic Charter, this comprehensive service includes medical facilities for athletes at both training and competition sites; a medical service for spectators, media and officials at the various Olympic facilities and hotels; coordination of ambulances, and hospital and diagnostic services. This can be a tremendous logistical exercise. In Tokyo in 1964, there were approximately 9,100 health care personnel providing medical services.

The center of Olympic medical care for the athletes is the polyclinic. Situated in the main Olympic Village, it offers a comprehensive range of services at no charge, including emergency services supported by ambulance transport; sport and general medicine; medical imaging; pharmacy; physiotherapy and massage therapy. Dental services are also provided at this location.

Dental Services at the Olympic Games

There has been considerable latitude in the level of dental service offered at previous Olympic Games, primarily due to the lack of firm direction within the Olympic contract. In fact, in the IOC Medical Commission guidelines, the requirements for dental service are listed simply as follows:

- Dental care

Dental care shall be available on an emergency basis only. Services to be provided shall include:

- Treatment of broken or injured teeth;
- Fillings;
- Replacement of caps; and
- Limited oral surgery.

There is a fundamental difference in the manner by which medical and dental care is sought by athletes. Aside from regular physical assessments,

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team physicals or elective massage, there are relatively few situations where a noninjured or healthy athlete seeks medical attention. While orofacial injuries are an unfortunate part of high-level competition, their treatment usually makes up only a small percentage of the overall dental service during any games. Similarly, as true dental emergencies (swelling, abscess etc.) can severely limit an athlete's ability to train or compete, part of the mandate of the Olympic dental service is to deal with these when they arise.

However, there are countless other situations where athletes may choose to seek dental care of a nonurgent or elective nature. Athletes may wish to have a simple check-up or cleaning. They may have a cavity or lost restoration that is not causing any pain or discomfort, but for which they would like treatment. They may have a nonpainful but necrotic tooth that requires endodontic treatment. They may have a large restoration that would benefit from a crown. Or, they may wish to obtain a custom-made mouthguard.

These situations arise because of the nature in which dental care is delivered in many countries. Typically, an athlete in training has access to medical and therapy care through their National Olympic Committee at little or no cost, which is important as many athletes are training with limited financial resources. Unfortunately, very few NOCs have programs to deliver dental care to their athletes. There are some exceptions such as South Africa, which offer a program to screen athletes in advance of the Olympic Games, and have arrangements made to complete any necessary treatment.[1]

However, unless socialized dentistry is available in their country, or the athlete has access to dental or other third-party insurance coverage, the costs will come out of their own pockets. Many athletes thus neglect their dental health while in training, but seek elective care during the Olympics because these services are provided free of charge.

The challenge to the organizing committee is to determine what services should be available and to what extent. The dental service has fulfilled its primary mandate when it can deliver "urgent and necessary care" to athletes with injuries, pain, or significant dental disease. It is in the determination of the additional or elective services that significant variation has occurred from games to games.

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The Dental Health of Olympic Athletes

Forrest gave one of the first in-depth indications of the generally poor health of athletes.[2] He conducted a basic examination of 35 members of the British Olympic team (about 14 percent of the team) prior to their departure for the Mexico City Olympics in 1968. He performed emergency treatment on two eventual gold medal winners who had caries encroaching the pulp, and also found a high use of glucose drinks or other sweets. His overall assessment of the dental state of his team was "very poor." He then made arrangements to assess the dental health of other participating countries during the games and, after examining more than 400 athletes from 30 countries, found many with both extensive caries and gingivitis.

Forrest documented two anecdotes that showed the ability of dental disease to adversely affect the quality of competition. A world-record holder presented to the clinic with severe pericoronitis and an apparent systemic infection. Although she received treatment, she was forced to drop out of her competition after having completed less than half the distance. Two other athletes refused treatment for apparent pulpitis and took part in their events while using large amounts of analgesic medication. Both were eliminated in the preliminary rounds. Forrest commented, "A dentally unfit mouth is a risk in that a crisis might occur at any time, and will then jeopardize the contestant's chances. It is impossible to know which unfit mouth will break down and become an emergency at the wrong time. There is a strong case for careful dental screening of all contestants."[2]

The article also made reference to comments from medical officers of other nations about the dental health of their own athletes. A Yugoslav medical officer referred to the dental condition of his team as "very bad … with many emergencies." A United States medical officer was very concerned about the "… poor dental state" of many members of his team, and noted that of 47 athletes participating in a pre-Olympic camp, there were seven dental emergencies.

The article concluded with a number of key recommendations that, although more than 30 years-old, are still worth considering today. The need for pre-Olympic assessments and education on the importance of good dental health was emphasized, and the completion of necessary dental treatment prior to the games was encouraged. Pericoronitis and other related third molar problems were mentioned as being of particular importance in this population. Oral hygiene education and materials should be available within the

village, possibly with the assistance of corporate sponsors.

In a similar vein, Callaghan noted that in a study of elite British cyclists, 21 percent (102 of 467) required further dental treatment following their routine screening exam, but many did not complete treatment due to dental phobia or other training issues.[3] He observed that "... the authors have experience at Olympic and Commonwealth Games of elite cyclists presenting with acute dental problems that could have been prevented by proactive dental care."

An article on the role that dentistry plays in the United States Olympic Committee pointed out that "... every pre-competition screening turns up several athletes with severely decayed or abscessed teeth."[4] The author also stated that one reason elite athletes may be more susceptible to dental emergencies is that many are between the ages of 18 and 23, when wisdom teeth are likely to cause dental distress. He suggested that "... dental neglect ... could mean that all the years of sweat and sacrifice leading to international competition can be compromised unnecessarily at the moment of truth by a tooth abscess or other dental emergency."

Similarly, Dr. Kenneth Clarke of the USOC made the somewhat controversial recommendation that "Dental fitness requirements should be insisted upon for the contestants from all countries participating in the Olympic Games."[2]

A 1994 examination of the U.S. biathlon team's 31 athletes revealed that:

- Eleven had not seen a dentist in more than two years;
- Twelve required wisdom tooth extraction;
- Six others might require wisdom tooth extraction;
- Two suffered from periodontal disease requiring treatment;
- Seven athletes had a total of 21 carious lesions; and
- Two needed treatment for TMJ disorder.

The author also noted that five years prior to instituting oral exams, four biathletes developed serious dental complications, and one was forced to return home for dental care. One athlete fractured a tooth and required immediate care on the eve of the 1994 Winter Olympic Games.[5]

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Drs. Ray Padilla and Emilio Canal examined 35 players during routine screenings of the USA Men's World Cup pool of soccer players in January 1998. Thirty-three of them had suffered a previous soft tissue injury, and 20 had incurred a hard tissue injury, including six who had teeth avulsed. Future treatment was required by 25 (71 percent), of the athletes and immediate care needed by six (17 percent).[6]

Kerr discussed the steps that had been taken to prepare American athletes prior to the L.A. Games in 1984. Dental assessments and treatments were made available at a number of pre-Olympic competitions. Athletes attending the 1983 Pan-Am and World University Games were screened and received treatment as required through the use of a mobile dental van with portable X-ray. A conservative estimate at that time was that 40 percent of the screened athletes required dental care. The USOC also took a lead role in using the Olympic Games to help promote the use of mouth protectors in both Olympic and other sports.[7]

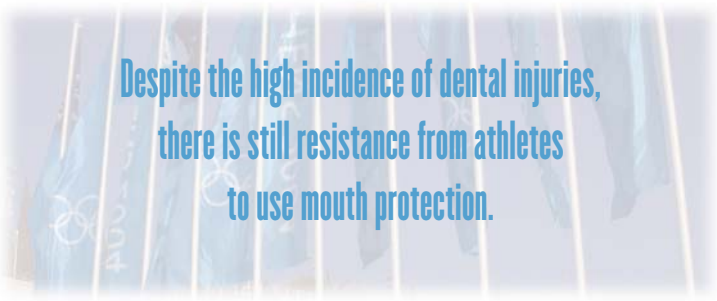
In any competition involving contact sports, injuries may play a significant role and many authors have discussed the injury potential of athletes competing in Olympic sports. Kvittem showed the high incidence of dental injuries in the Olympic sports of soccer, wrestling, and basketball.[8] Linn's review of facial injuries in the Netherlands confirmed, in addition to dental injuries, a high incidence of facial fractures, and any Olympic program should also be prepared to deal with this serious injury.[9]

Mouthguards have been shown to be effective tools in the battle against dental trauma. Garon proposed mouthguards for many sports, including the Olympic sports of baseball and basketball.[10] In Dreyer's article, Dr. Jim Gallman was quoted as stating "If every piece of protective equipment was as effective as the oral mouth protector, there would be no sports-related injuries at all."[11] McNutt recorded 69 oral injuries in baseball and basketball, 67 of which occurred in athletes not wearing mouthguards.[12] Duda and others have shown the effectiveness of introducing regulations requiring compulsory mouthguard use. In American football, the compulsory use of mouthguards reduced the incidence of orofacial injuries from 50 percent of all injuries to less than 1 percent.[13]

Concussions are another consequence of high-level competition. Barth presented specific information on concussion incidence in the Olympic sports of boxing, soccer and equestrian, and proposed a mathematical model to quantify the role that mouthguards may play in reducing concussion incidence or severity.[14] Biasca, concentrating his report on the Olympic sport of ice hockey, showed a very high incidence of

both head and orofacial injuries, and felt that the potential benefits of mouthguards from both an orofacial and neurological standpoint justified their use. He also pointed out that the International Ice Hockey Federation introduced a regulation regarding compulsory mouthguard use.[17] McNutt also agreed with the neurological benefits of mouthguards, stating with regard to football that "... mouth protectors are very effective at reducing concussions."[12] McCrory however, while acknowledging the benefits of mouthguards in reducing dental injuries, pointed out that inadequate research exists to develop a science-based argument for any relationship between these devices and a reduction in concussions.[15,16]

Despite the high incidence of dental injuries, there is still resistance from athletes to use mouth protection. Chapman, reviewing Australian data, noted that approximately one-third of all dental trauma resulted from sporting injuries, but in only 1 in 20 occurrences was a mouthguard worn.[18] Bolhuis showed that while 1 in 5 field hockey players sustained at least one serious dental injury during their careers, only 20 percent of international players chose to wear a mouthguard. The main deterrent was education about the potential benefits.[19]



Physical Set-up of the Olympic Dental Service

The first significant recorded data from the Olympic Games dental service was from Los Angeles in 1932. Commendations should go to the medical director who felt that "... great emphasis should be placed on the importance of dental hygiene in the care of the athletes," which was accomplished by using a donated "traveling health mobile" in the Olympic Village, along with a staff of 27 dentists. The official report notes that "... probably for the first time in Olympic history, toothaches, decayed teeth, exposed nerves and other dental troubles which might impair the efficiency of the athlete on the eve of a contest received immediate attention."[21]

At the following Olympic Games in Berlin in 1936, only three dentists were used at a clinic in the Olympic Village.[22] Similar data was recorded from Tokyo in 1964, where three dentists and three nurses used three dental chairs in the Olympic Village to provide treatment. This was a relatively small program, considering that more than 9,100 health care professionals were involved in these games.[23]

In 1968, at the Winter Olympics in Grenoble, the dental service was turned over to private clinics in the region, a decision that meant athletes had long distances and long waits for treatment. At the Summer Games that same year in Mexico City, two full-time dentists used a clinic in the Olympic Village to provide the dental service.[24]

In Sapporo in 1972, a small medical clinic, including a dental clinic, was established in the Olympic Village and provided treatment daily between 9 a.m. and 5 p.m.[25] A more extensive program was developed for the Munich Olympics later that year, with four chairs in two locations and 21 dentists providing treatment from 6 a.m. to 10 p.m. during the games.[26]

This standard model was again used in Montreal in 1976, where 32 dentists provided extensive care, available 24 hours a day, either on-site at the polyclinic or on-call. These games were the first to have provided venue coverage for the athletes — dentists equipped with appropriate instruments and IOC-approved medications — either in attendance at competition sites or available within 30 minutes to render emergency treatment.[27]

At Lake Placid in 1980, emergency dental treatment was defined as "... the treatment of dental anomalies and buccal pathologies which could prevent an athlete from performing to the best of his/her ability during the Games." The treatment policy was outlined as "... treatment is to be of an emergency or temporary nature, except when in judgment of the dentist on duty a more permanent treatment is indicated. However, the clinic is not to be responsible for any treatment or repair of a nature that would require extensive time." Eighteen dentists provided treatment through the polyclinic between 6 a.m. and 11 p.m. usually with one on-site and one on-call dentist.[28]

One of the more extensive and well-documented dental services was developed for the 1984 Olympic Games in Los Angeles. There were a number of innovations at these games. The importance of pre-Olympic screening was recognized and a portable van with X-ray equipment traveled to various pre-games competitions to examine athletes and arrange treatment.

On-site dentists were used selectively at soccer, water polo, and basketball. As an indication of the usefulness of this program, during a pre-Olympic water polo tournament in 1982 a player lost four teeth due to contact with the goalpost. He received both immediate and follow-up care, along with a

mouthguard, and was able to return for the next game.[27] These were also the first Olympic Games with a mouthguard program for athletes. Three dental clinics were established (one at each village) with a total of five operatories. Volunteer dentists committed to 30 days during the games, along with their involvement in pre-Olympic competitions.[29]

In 1988, Calgary used a 2,000-square-foot mobile clinic that was sent to northern Alberta after the games. The clinic was outfitted with state-of-the-art equipment, and was open from 1 p.m. to 7 p.m. daily, with an on-call service for emergencies. Treatment was provided by three dentists and three assistants. Some private offices were also used to treat emergencies at outlying venues.[30]

A different model was used in Albertville in 1992, where budget constraints caused the proposed Olympic Village dental clinic to be scrapped in favor of private clinics in Brides Les Bains, Val-d'Isère, and La Plagne. One chair was also set up in Les Saisies for use of a private dentist for emergency treatment.[31]

Following the Los Angeles model, Dr. Esteban Brau and his staff used nine dentists and a two-chair clinic during the Barcelona Games of 1992. The clinic became a social medicine clinic and is still in use today.[32]

At the 1994 Winter Games, dental services were offered by 13 dentists in four locations: the main public clinic in Lillehammer (10 operatories); a clinic in the Olympic Village, (one operatory); a field unit with two operatories; and the regional hospital in Lillehammer (for advanced oral surgery). The large number of clinics resulted from the organizers commitment to provide treatment for 3,500 Olympic family members; 13,000 volunteers and functionaries, and approximately 100,000 spectators daily.[33] A more standard model, consisting of a one-room, two-chair operatory, was used during the following 1998 Winter Olympics in Nagano.

The importance of oral hygiene was emphasized during the Atlanta Olympics in 1996. In addition to a three-chair dental clinic in the polyclinic, there was also an athlete health education center located within the village. Three different sections allowed athletes to learn about various aspects of vision, hearing, and oral health. Upon providing evidence of participation in all three components, athletes were given a complimentary electric toothbrush.[34]

With the support and guidance of the IOC medical committee, a comprehensive dental program was developed for the Sydney Olympics in 2000. Dental care was provided in a four-chair dental clinic with an on-site laboratory. Patient records were computerized, and digital radiography, including a digital orthopantomogram, was available. The clinic was open daily from 8 a.m. to 11 p.m.

One initiative was the provision of pressure-laminated mouthguards for athletes in contact sports including basketball, field hockey, water polo, and soccer. An oral health program was also designed to promote the importance of overall good dental health to the athlete. A key component of this program was the distribution of the IOC-sponsored brochure "Sports Dentistry and the Olympic Athlete." This educational document was produced in English, French, and Spanish, and was distributed in the dental clinic and to each of the 199 NOCs in attendance at these games.

Treatment Statistics from the Dental Service

It is a statistical challenge to directly compare dental treatment statistics from different games as there has never been a standardization of the Olympic data-collection system. In some cases, the number of visits was tracked while in others, the number of procedures was noted. Athlete visits were not always separated from visits by delegation members, volunteers, or staff. An athlete reporting for an examination, two radiographs and a three-surface restoration would be recorded in some cases as having had four procedures, while in other cases, would simply be one visit to the clinic. Occasionally, treatment was sorted by age, sex, sport, or country.

Some trends and tendencies do become apparent, and though the pool of data is too extensive for complete analysis within this paper, the key points will be noted and a chart summarizing the findings (**Table 1**) can be found at the conclusion of this section.

The earliest data comes from Berlin in 1936, where 147 athletes received a total of 473 treatments, including 33 radiographs. Two athletes were treated for jaw fractures.[22] No other reliable data is available until Tokyo in 1964, where 202 dental cases were treated, including 60 cases of Class I and II caries, and 16 dental fractures. A large number of the patients came from athletics (53) and basketball (19), which may be reflective of the overall participation numbers.[23]

In Mexico City in 1968, there were more than 1,000 emergency visits with more than 400 sedative or permanent dressing placed to treat caries. Additionally, 370 teeth were extracted; more than 40 patients received endodontic treatment; and third molar pericoronitis was particularly noted as one of the persistent problems in the clinic, with more than 40 cases.

Staggering data also came from the Munich Games of 1972, with the staff of 24 dentists treating close to 2,300 patients and performing close to 1,400 surgical procedures. There were 3,359 restorative and endodontic procedures. It is believed these statistics include treatment performed outside of the Olympic family, on both volunteers

Table 1

Summary of Recent Olympic Games Dental Treatment Statistics

		Los Angeles	Calgary	Seoul	Albertville	Barcelona	Lillehammer	Atlanta	Nagano	Salt Lake City	Athens
		84	88	88	92	92	94	96	98	02	04
	Total number of athletes	6829	1423	8391	1807	9356	1737	10318	2176		
Visits	Athletes	359	36	280	36	356	112	578	134		278
	Others	185	6	548	20	327	413	388	126		287
	Total	544	42	828	56	683	525	906	260	311	565
Procedures	Restorations	174	10		42	222	353	473	164	224	356
	Endodontic	63	13		15	81	80	72	35	48	144
	Periodontal	74	3		2	11	29	44	18	56	167
	Prosthetic	50	3		5	35	16	16	15	0	22
	Extractions	49	4		5	60	57	88	7	11	49
	Mouthguards	25	0		0	1	0	6	0	11	56

and spectators, but they are still impressive.[26] In comparison, approximately 300 athletes and another 130 staff were treated during the subsequent 1976 Olympic Games in Montreal.[27]

At Lake Placid in 1980, 68 patients sought treatment, 30 of them athletes. Nineteen cases of caries, 12 of pulpitis, and 11 fractures represented a majority of the diagnosis, while treatment included 40 permanent or temporary dressings, five extractions, and three endodontic procedures.[28]

Approximately 20 athletes sought treatment at the next Winter Games in Sarajevo in 1984, with the remainder of the 137 patients being staff, officials or others.[35]

During the 1984 Los Angeles Games, more than 500 patients received treatment, with close to 70 percent of them being athletes. Pulpitis and caries were the cause of more than 200 visits, and pericoronitis was again prominent with 50 cases. There were also more than 40 fractures or trauma cases. Treatment included close to 174 permanent or temporary restorations, 49 extractions, and 63 endodontic procedures, and in an apparent Olympic first, 25 mouthguards were fabricated.[29]

Data from the subsequent two Olympic Winter Games, Calgary in 1988 and Albertville in 1992, were quite comparable. Forty-two patients were treated in Calgary, 36 athletes, and six support staff. Treatment included 20 restorations, four extractions and 13 endodontic procedures.[30] In Albertville, a total of 56 patients, 36 who were athletes, received 42 restorations, 14 endodontic procedures and five extractions. Close to one-third of the patients were from Russia.[31]

There is little data from the 1988 Summer Games in Seoul, although we do know that 828 individuals, including 280 athletes, were treated, making dentistry the third most utilized service within the Village Medical Center. Interestingly, the next most popular service was acupuncture, with 724 patients.[36] There is, however, excellent data from the following games in Barcelona in 1992. During the 32 days the clinic was open, 681 patients received treatment, including 356 athletes. The age range of athletes was 15 to over 60, and the average age was 34. The sports of athletics and boxing provided the largest numbers of patients, and citizens of the former Soviet Bloc, including Belarus, Moldavia, Ukraine and Kazakhstan, made up more than 100 of the patients.

One particular case deserves mention. An athlete who was one of the top five marathon runners in the world developed an abscess and required an extraction the day before her race. Not surprisingly this athlete, after four years of training, had a very poor result the next day.

Close to 200 patients presented in Barcelona with either lost restorations, including crowns and bridges, or fractured teeth. Almost 100 suffered from acute apical abscess and 31 were diagnosed with pericoronitis. Treatment included more than 200 restorations, 81 endodontic procedures and 60 extractions.[32]

The data collected in Lillehammer in 1994 showed more than 400 patients were treated, including 112 athletes.

Their service also offered care to a large number of functionaries and spectators, and many of the patients were from Russia, Ukraine, and Kazakhstan. Treatment included more than 350 restorations, 80 endodontic procedures and 57 extractions.[33]

In 1996, the Atlanta Olympic Games dental service provided treatment for 906 patients, 518 of whom were athletes. There were 473 restorations placed, and 72 endodontic procedures were performed. Unfortunately, 88 teeth were also extracted. Again, 19 percent of the patients came from the former Soviet Bloc, primarily Ukraine, Russia, and Belarus.[34]

During the 1998 Winter Olympics in Nagano, dentistry was the fourth most-requested service at the polyclinic, making up nearly 20 percent of all visits. A total of 260 dental patients received 164 restorations, 35 endodontic procedures and seven extractions. Seventeen percent of the patients came from each of Russia and Ukraine, and another 9 percent were from Kazakhstan.[37]

No official treatment data was ever made available by the organizers of the Sydney Olympic Games of 2000.

Dental Service at Recent Olympic Games

While the previous historical overview was designed to illustrate the development of some trends and tendencies, the current state of both athlete dental health and the Olympic dental service can be best seen by a detailed look in detail at the two most recent events, the 2002 Olympic Winter Games in Salt Lake City and the 2004 Summer Olympic Games in Athens.

Salt Lake City, 2002

Under the direction of Lynn Powell, DDS, of the University of Utah, a two-chair dental clinic was established within the polyclinic. Both panographic and intraoral radiographs were available. The clinic was open daily from 8 a.m. to 8 p.m., and there was a dentist on-call after normal clinic hours. The university hospital dental clinic was also available for after-hours emergencies.

There were 14 dentists and 12 dental assistants, with one dentist/assistant team scheduled per shift. Four dental specialists were on-call, but only the endodontist was used extensively.

A total of 311 patients visited the clinic. There were 224 restorations placed and 48 endodontic procedures performed. Eleven teeth were extracted, and 11 custom mouthguards were fabricated. With dental cleaning being available, 56 patients took advantage of this treatment, and approximately 500 radiographs were taken.

There was also a team of dentists who provided venue treatment at the men's ice hockey games. Injury statistics provided by the IIHF's Injury Reporting System predicted between seven and 11 orofacial injuries during the Olympic competition, and in fact, seven dental injuries were reported and treated. Of those injured, six returned to play within a few minutes, and one was forced to retire from competition.[38,39]

Athens, 2004

Dr. George Vougiouklakis and the staff of the University of Athens dental school created an excellent dental service for both the Olympic and Paralympic Games. The primary treatment venue was a five-room clinic within the polyclinic. One large room held three dental chairs while a single chair, for either surgery or confidential consultation, was in a second room. There was also a small laboratory, a business office and a staff room. A digital panorex unit was in the final room, and digital X-ray units were available at all chairs. A computer system was networked not only to the entire dental suite, but also to the other imaging units within the polyclinic, allowing immediate access to CT, MRI, or ultrasound images if needed.

There were approximately 28 dentists and/or specialists (virtually all staff members from the university) and the same number of support staff. Many of the auxiliaries were senior dental students. The clinic was equipped to perform all dental procedures, and was open for approximately 15 hours each day. The clinic began operation 10 days before the start of the games and, except for a short break, continued to offer treatment through the end of the Paralympic Games which followed the Olympics. Translation services were readily available within the polyclinic, as were immediate consultations with other health care professionals.

Table 2

Summer Olympic Games — Dental Patients

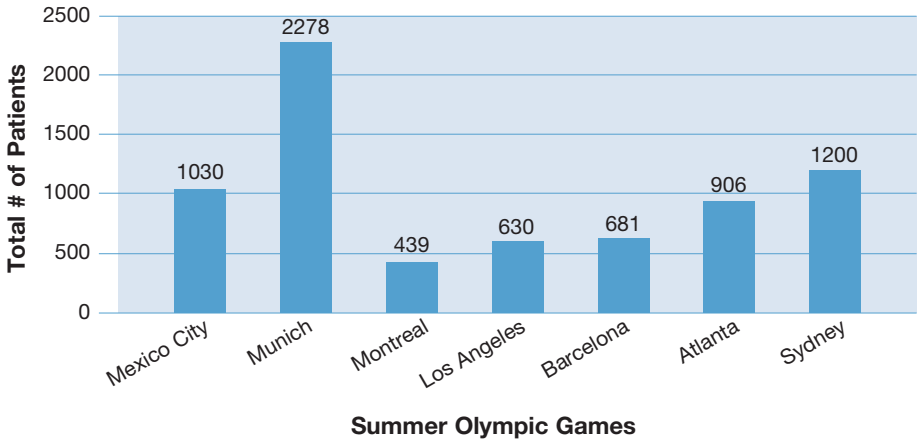
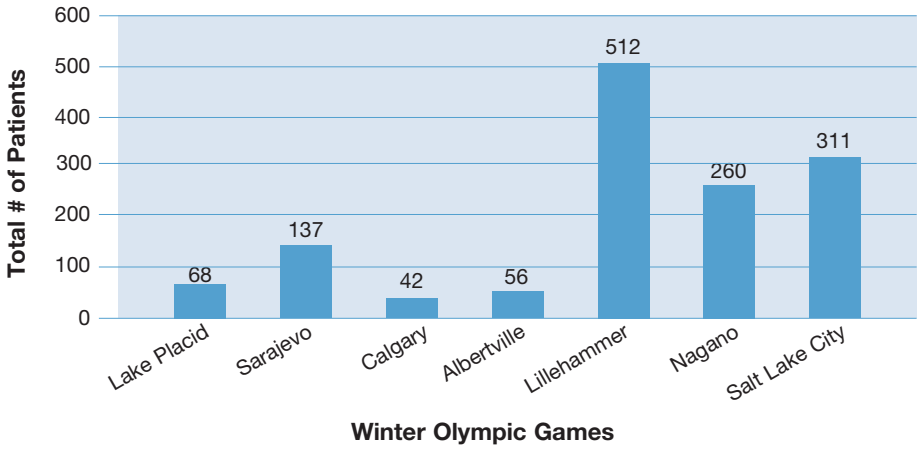


Table 3

Winter Olympic Games — Dental Patients



The clinic also offered custom-made pressure laminated mouthguards and many of the athletes, especially boxers, took advantage of this opportunity. Five traumatic injuries (lateral luxations of five teeth in two athletes; one avulsion; one orbital bone fracture; and one cusp fracture) occurred during the boxing competition. Other injuries were documented in sailing (enamel fracture), tae kwon do (crown-root fractures of two teeth) and wrestling (lateral luxations of two teeth). Vials with Hank's balanced solution, along with written protocols, were distributed to venue physicians serving at events with a high potential for traumatic injury.[40]

Discussion

While it is not scientifically appropriate to directly compare the data from different games due to the differences in nomenclature and collection

Table 4

Extractions vs. Endodontics at Various Games

Event	Extractions	Endodontics
Mexico City (68)	370	43
Los Angeles (84)	49	63
Barcelona (92)	60	81
Lillehammer (94)	57	80
Atlanta (96)	88	72
Nagano (98)	7	35
Salt Lake City (02)	11	48
Athens (04)	49	144

methods, one can find certain trends, tendencies, changes, and other concepts within this data.

The utilization of the dental service by athletes and officials over the last 30 years is clearly increasing. At the Summer Games (**Table 2**), the number of dental patients has increased steadily since Montreal, and the same can be said for the Winter Games (**Table 3**) from Calgary to Salt Lake City. (The 512 patients seen in Lillehammer reflects the large number of volunteers treated.)

Some of this gain can be explained by the overall increase in the number of athletes participating at the Olympic Games and the number of sports that are now included. We should expect the demand on this service to continue to increase, as the dental needs of both athletes and officials are not being properly dealt with at home.

One visible trend is a greater attempt to save teeth as opposed to extracting them (**Table 4**). In Mexico City, for example, it is estimated that 370 extractions were done and only 43 endodontic procedures. This can be compared with the Atlanta in 1996 (88/72); Nagano in 1998 (7/35); and Salt Lake City in 2002 (11/48). Part of this trend may be the result of better oral hygiene by the athletes or improved access to treatment in their home country. Another reason may be that the Olympic dental service has expanded from an emergency-only clinic where little but extractions was offered. Regardless of the reason, this trend toward keeping instead of extracting teeth is one that should be promoted, planned for, and encouraged by future games organizers.

There is also a greater tendency to provide permanent instead of temporary restorations. As **Table 5** confirms, a majority of restorations placed at the more recent Olympic Games have been permanent, while this was not the case, for example, in Lake Placid in 1980. Part of the movement to permanent restorations may be a technical one, in that "near" pulp exposures can now have solid and stable liners placed and be immediately restored. It is more likely that this trend reflects the establishment of clinics with sufficient volunteers with permanent restorative materials at their disposal.

A common theme is the regular appearance of pericoronitis as a problem during the games. The number of reported cases is in some instances staggering, with more than 40 from Mexico City in 1968; seven from Lake Placid in 1980; 53 from Los Angeles in 1984; 31 from Barcelona in 1992; and 39 from Lillehammer in 1994. This should be no surprise considering the age range of the competitors, but as pericoronitis can be a debilitating condition, significantly inhibiting performance, this problem must be identified and treated well in advance of the games.

The Olympic dental service must primarily take care of the athletes. In most cases where this type of data was kept, more than 50 percent of all treatment was provided for athletes (**Table 6**). This is an objective that organizing committees must maintain, and at recent games, after dealing with true emergencies from any member of the Olympic family, elective or nonurgent treatment has been limited to the athletes only.

Recognition of the importance of the dental service has resulted in an increase in the number of dental volunteers and staff. While only two dentists managed the needs of the athletes in Mexico City and three in Calgary, there were a reported 50 dentists in Sydney and 14 in Salt Lake City. Since in most cases the dentists were volunteers, and there was little ancillary cost aside from food and outfitting, organizers should be encouraged to ensure there is an adequate dental staff to best treat the needs of the athletes. With additional staff, chairs and time, more teeth can be saved and fewer extracted.

Trauma is an ongoing problem, with reported cases of fractured jaws, avulsed and loosened teeth, and dental fractures during competition and training. This data confirms the importance of having trauma-trained dentists both on-site at certain venues, and within the clinic, to deal with these injuries promptly and allow the athletes to return to competition.

Whenever dental cleanings have been made available this service has been well-utilized, as evidenced by 74 treatments in Los Angeles, 44 in Atlanta and

Table 5

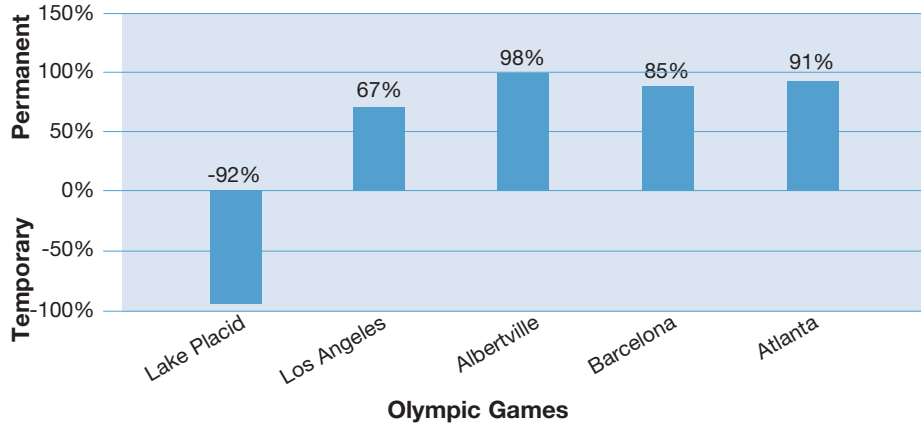
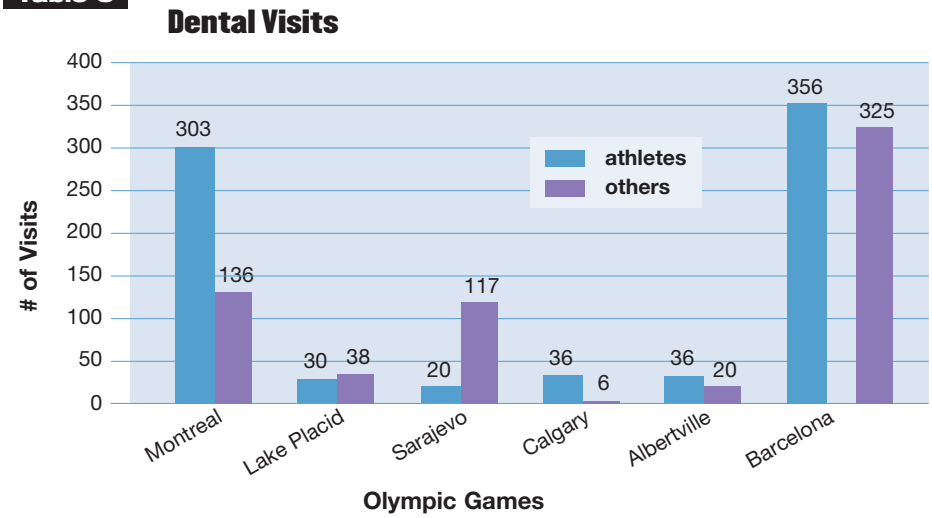


Table 6



56 in Salt Lake City. If dental hygienists are available, they should be utilized as a part of the dental services team.

Another fairly consistent tendency is the geographic distribution of patients. While this data was not kept from all games, athletes from the Eastern Bloc, or former Soviet Union, made up a significant number of the patients in Barcelona, Lillehammer, Atlanta, and Nagano. Personal communication also indicated this to be the case in Salt Lake City and Athens. In some cases, there has been a significant patient base from Africa or Cuba. These national trends must be further investigated so that both the IOC and NOC's can try to identify and treat these athletes before and between, not during, the Olympic Games.

Recommendations for an Ideal Model

This paper has outlined the significant variation in the level of dental care provided at the Olympic Games over the last decades. While in all cases the need to effectively treat emergencies has been met, there have been major differences in the type of clinic established, the equipment available, the level of staffing, the services provided, the materials used and the inclusion of auxiliaries and specialists.

The dental services at the Olympic Games should reflect that the best athletes in the world are present and are entitled to an elite level of care. Further, just as the Olympic Games are a showcase for technology in such areas as communication, security and transportation, so too should the dental clinic use the best technology available. A number of recommendations for establishing an ideal dental service are outlined below.

Mode of Dental Treatment Delivery

Of the many reported methods of delivery (contract out to private dentists – Grenoble (1968); Albertville (1992); create a clinic from a trailer or other module – Nagano (1998); use a self-contained mobile dental clinic - Los Angeles (1932); Calgary (1988)), the most effective and efficient delivery system is the establishment of a proper dental clinic within the Village Polyclinic. This ensures convenience and security, and allows the use of shared services such as reception and translation. Joint consultation with other health care colleagues on difficult cases is readily available. The clinic can have the appearance of a regular dental office, making it appear both more professional to the athletes and more familiar to the dentists and staff providing treatment. In some cases, the clinic can be retained for public or private use following the games.

Physical Set-Up of the Dental Clinic

The ideal dental clinic should accommodate a reception area, an appropriate number of operatories, an instrument cleaning and sterilization area, a storage area, and a small laboratory area. In many cases the reception area can be shared with the rest of the polyclinic.

An analysis of the requirements for athlete care indicates that between six and eight chairs would be ideal for a Summer Olympic Games of approxi-

mately 12,000 athletes, while four chairs would be required for an Olympic Winter Games of approximately 3,000 athletes. Operatories must be of reasonable size as there are often extra people brought into the treatment area with the patient such as coach, team doctor or therapist, or interpreter. A modular cabinet system might be considered, as it provides not only the space for supplies and equipment but can also serve as a room divider, reducing some need to erect walls.

The most up-to-date equipment and supplies, digital periapical and panographic X-ray, air abrasion, laser technology, electronic apex location, and other state-of-the-art devices should be available along with all available modern restorative materials, bonding techniques and cements.

Services Provided

The most common services were examinations, radiographs (both periapical and panographic), restorations (permanent and temporary); root canal treatment (complete or partial); hygiene or periodontal treatments, and extractions. The clinic must also be prepared to deal with all potential traumas, including the replantation of avulsed teeth and fixation of luxated teeth. Severe trauma or alveolar fractures may be referred to an outside clinic or hospital once stabilized.

The hygiene or periodontal needs of the athletes are reasonably high, and since any time hygiene services have been available they have been well-utilized, there should be an attempt to provide and expand these services.

Mouthguard Program

With the significant advances in mouthguard technology and evidence of their effectiveness, many organizations have now officially endorsed or mandated the use of these protective devices. At the Summer Olympic Games, a mouthguard program should be available to athletes competing in basketball, field hockey, boxing, martial arts, volleyball, cycling, water polo, and soccer. At the Olympic Winter Games, athletes competing in ice hockey, slalom skiing, aerials, and skeleton should have access to pressure-laminated guards.

Venue Coverage

A dental clinic some distance from the competition venue will not facilitate the quick return to competition for an athlete with a serious laceration, tooth avulsion, dental fracture or jaw dislocation, especially in light of current trauma protocols calling for replantation within five minutes for the best chance of success. These dental emergencies should be treated at the field-of-play by experienced and properly equipped sport dentists.

Of the Olympic sports, consideration should be made for having a venue dentist at ice hockey, boxing and some of the martial arts sports, such as tae kwon do. On-call or on-site dentists may also be useful in basketball, field hockey and soccer, especially in the medal round matches. As the National Basketball Association, Major League Soccer, and National Hockey League in North America usually have a dentist on-site for all games, this standard should be considered for Olympic athletes as well.

Staffing

Clinic staff should include general dentists, hygienists, dental assistants and specialists in both endodontics and oral surgery. Other specialty and laboratory services should be available on a referral basis. One or two full-time staff should be present while other staff should be able to provide a maximum number of shifts. The more field-experienced of the general staff might be assigned to venue coverage. The clinic hours and staff should reflect the population of the Olympic Village, which increases as the opening day approaches. Hours during the Olympic Games should be 8 a.m. to 10 p.m., with a 24-hour on-call service available.

Dentistry must also be fully represented on the organizing committee, as the dental service is one of the most heavily utilized. A well-run dental clinic at the Olympics will impact with such areas as volunteer and athlete services, venue management, transportation, accreditation, and food services. There will also be significant liaison required with local and international dental societies, various government agencies, local universities and other teaching institutions, dental suppliers and manufacturers, and groups representing auxiliaries. Design, construction and equipment and supply procurement will need to be closely supervised and a staff selection process developed along with schedules and protocols.

Thus, a director of dental services should be appointed as early as possible, and should be a part of the core medical commission for the Olympic Games. He or she should head a dental subcommission with appropriate personnel assigned to deal with the entire dental service.

Other Recommendations

Many authors, including the British Dental Association, have reported on the potentially harmful effects of sport beverages on the athlete's dentition.[41] This damage can be reduced or eliminated if water is also made available to the athletes. Chilled sport beverages are also less erosive to the enamel, and acidic beverages, if used during competition, should be avoided during the remainder of the day to give the enamel an opportunity to remineralize. Bottled water should be available at all sporting venues as an alternative to sport beverages and energy drinks. Athletes should be educated on the potential harmful effects of these beverages and techniques for minimizing this damage

Both the IOC and World Anti-Doping Agency publish a list of banned or restricted drugs and procedures. A number of items on these lists might be used by a dentist in the regular course of practice. These agents may include, but are not limited to, analgesics, corticosteroids, local anaesthetics, decongestants, and stimulants. Any dentist working with athletes before or during the Olympic Games must be aware of the current doping regulations to prevent an inadvertent positive test.

Education initiatives should be undertaken in multiple languages to provide athletes with information on the relation of oral health to performance; the dangers of smokeless tobacco; the benefits of proper mouth protection and other key topics.

Data collection and survey completion must be done in an accurate and responsible manner during the games, as this data will be part of a continuing stream that will make the set-up and running of the dental service at future games more effective and productive.

Summary and Conclusions

The dental health of athletes is often poorer than that of the general population, and may result in acute or chronic problems that can compromise an athlete's performance. The possibility of an athlete losing four hard years of training due to an avoidable dental illness or injury is unacceptable, and steps must be taken to prevent these occurrences.

Access to adequate dental care is compromised in certain parts of the world, and a disproportionate amount of treatment has been sought at the Olympic Games by athletes from Eastern Europe and, in some cases, African nations. Further assessment of this problem must take place, and a system to help educate and deliver a better level of care to these athletes, through their NOCs, must be developed. A partnership with global bodies, such as the International Society for Dentistry and Sport, might help with this initiative.

The dental health of athletes is often poorer than that of the general population, and may result in acute or chronic problems that can compromise an athlete's performance.

Games organizers must establish dental programs that best meet the needs of the athletes, using the recommendations included in this report which are based on trends in the dental service that have been identified over the last 30 years. These include:

- Providing both emergency and elective dental treatment;
- Performing more permanent and less temporary restorations;
- Retaining more teeth and extracting fewer;
- Having hygiene services available;
- Providing screenings and necessary radiographs;
- Opening the clinic during hours that work best for the athlete; and
- Ensuring that elective dental treatment is prioritized for the athletes.

Ideally, if all parties were able to work together to assess and treat athletes at home prior to their departure for the Olympic Games, the Olympic dental service might return to being solely for emergencies and trauma. This should be the ultimate goal for everyone involved. Until that happens, however, addressing the needs of the athletes by providing an enhanced dental service during the Olympic Games must continue. With the tremendous support of both volunteer dentists and corporate partners, and the encouragement of the IOC and the games organizers, it is expected that an appropriate dental service, as outlined in this paper, will be available in Torino in 2006, Beijing in 2008, Vancouver in 2010, and beyond. Hopefully, this paper will have provided the cornerstone for the development and implementation of that service for these and future games. CDA

References / **1.** Operation Excellence. Olympic Update. National Olympic Committee of South Africa, August 2000.

2. Forrest JO, The Dental Conditions of Olympic Games Contestants - a pilot study, 1968. *Dent Pract Dent Rec* 20(3):95-101, 1969.

3. Callaghan MJ, Jarvis C, Evaluation of elite British cyclists: the role of the squad medical. *Br J Sports Med* 30:349-53, 1996.

4. USOC, Sports Medicine Council. The Dental Family in the Olympic Movement. *Olympian* 9(4):14-15, 1982.

5. Lundell MI, et al, Benefits of Oral Screening and Management of the U.S. Olympic Biathlon Team. Proceedings of Fourth IOC World Congress on Sport Sciences in October 1997 in Monaco. Published by International Olympic Committee in Lausanne, 1997.

6. Personal communication, Dr. Ray Padilla.

7. Kerr IL, Going for the gold. Dentistry's role in the Olympics. *J Am College Dent* 51(2):12-4, 1984.

8. Kvittem B, et al, Incidence of orofacial injuries in high school sports. *J Public Health Dent* 58(4):288-93, Fall 1998.

9. Linn EW, et al, Facial injuries sustained dur-

ing sports and games. *J Maxillofac Surg* 14(2):83-8, April 1986.

10. Garon M, et al, Mouth protectors and oral trauma: a study of adolescent football players. *J Am Dent Assoc* 112(5):663-5, 1986.

11. Dreyer R, On guard. *RDH Magazine* 9(1):20, 22, January 1989.

12. McNutt T, Shannon SW Jr, Wright JT, Feinstein RA, Oral trauma in adolescent athletes: a study of mouth protectors. *Pediatr Dent* 11(3):209-13, 1989.

13. Duda M, Which athletes should wear mouth guards? *Physician and Sportsmedicine* 15(9), 1987.

14. Barth JT, Freeman HR, Winters JE, Management of sports-related concussions. *Dent Clin North Am* 44(1):67-83, 2000.

15. McCrory P, Do mouthguards prevent concussions? *Br J Sport Med* 35(2):81-2, 2001.

16. Aubry M, Summary and agreement statement of the first international conference on concussion in sport, Vienna 2001. *Br J Sports Med* 36(1):6-10, 2002.

17. Biasca N, et al, The avoidability of head and neck injuries in ice hockey: an historical review. *Br J Sports Med* 36(6):410-27, 2002.

18. Chapman PJ, Mouthguards and the role of sporting team dentists. *Aust Dent J* 34(1):36-43, 1989.

19. Bolhuis JH, Leurs JM, Flogel, GE, Dental and facial injuries in international field hockey. *Br J Sports Med* 21(4):174-7, December 1987.

20. Onyeaso CO, Adegbesan OA, Orofacial injury and mouthguard usage by athletes in Nigeria. *Int Dent J* 53(4):231-6, August 2003.

21. Official Report of the games of the XII Olympiad Los Angeles 1932: Los Angeles Organizing Committee p 190.

22. Official Report - Games of the XIII Olympiad Berlin 1936: Berlin Organizing Committee p 198-200.

23. Official Report - Games of the XVIII Olympiad Tokyo 1964: Tokyo Organizing Committee p 147.

24. Official Report - Games of the XIX Olympiad Mexico City 1968: Mexico City Organizing Committee 2:169.

25. Official Report - XI Olympic Winter Games of Sapporo 1972: Sapporo Organizing Committee p 383-7.

26. Official Report - Games of the XX Olympiad Munich 1972: Munich Organizing Committee vol. 1:372-6.

27. Official Report - Games of the XXI Olympiad Montreal 1976: Montreal Organizing Committee p 456-7.

28. Official Report - XIII Olympic Winter Games of Lake Placid 1980: Lake Placid Organizing Committee p 186–91.

29. Personal communication, Drs. Rick Lawson and Ray Padilla.

30. Personal communication, Dr. Mike Geraldi.

31. Official Report - XVI Olympic Winter Games of Albertville and Savoie: Albertville Organizing Committee p 214.

32. Brau E, Informe de la atencion bucodental en el servicio de odontologia de la Villa Olimpica durante los juegos de la XXV Olimpiada Barcelona '92. *Avances en Odontoestomatologia* 10:357-362, 1994.

33. Official Report - XVII Olympic Winter Games of Lillehammer 1994: Lillehammer Organizing Committee II:95-103.

34. Personal communication, Dr. Alda Underwood Hall.

35. Official Report - XIV Olympic Winter Games of Sarajevo 1984: Sarajevo Organizing Committee p 147.

36. Official Report - Games of the XXIV Olympiad Seoul 1988: Seoul Organizing Committee p 780.

37. Personal communication, Drs. Kasahara, Watanabe, Ogasawara, Otsuki – Matsumoto Dental University.

38. Powell L, Henry K, An Olympic spirit of teamwork. *Dent Econ* April 2002.

39. Personal communication, Dr. Lynn Powell.

40. Personal communication, Dr. Eleftherios (Terry) Farmakis.

41. Sports and Dental Health. BDA Fact File. *Br Dent Assoc* July 1997.

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