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Indigenous Australians and Oral Health

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1. Introduction

Indigenous disadvantage is an ongoing problem in Australia. In terms of health, the situation is critical. Indigenous Australians¹ experience higher rates of chronic disease, the persistence of serious ear and eye infections amongst young children, and often poor access to primary health care facilities (Aboriginal and Torres Strait Islander Social Justice Commissioner, 2005). In the area of oral health, there is also a wide disparity between Indigenous and non-Indigenous Australians. Unfortunately available data on the oral health of Indigenous people is limited, making it all the more difficult to make progress towards eliminating this discrepancy. The reasons for the gap are many, but include the fact that culturally appropriate and timely dental care are often inaccessible, as are appropriate resources on how to maintain good oral health, particularly for those residing in rural and remote areas. Differing understandings of health, as well as the division between medicine and dentistry that has traditionally been so strong in Australia, do nothing to help the situation. Reducing the disparities in oral health between Indigenous and non-Indigenous groups is an immense task that will require a dedicated and coordinated approach – it will depend on improved access to dental care as well as a more holistic approach to oral health, including preventive measures.

In the past, Indigenous Australians enjoyed better oral health than non-Indigenous people (Harford et al., 2003). Dental decay and periodontal disease were uncommon in rural and remote Indigenous communities up until recently. Caries was, throughout the 19th and early 20th centuries, regarded as a disease of affluence in Australia – but has now become an ‘indicator of deprivation’ (Williams et al., 2011). As foods rich in fermentable carbohydrates became more common in rural and remote areas, so did dental decay (Harford et al., 2003). While oral health risk factors are the same for all Australians, many Indigenous people do not enjoy the same access to protection from dental decay afforded by fluoridated water, toothpaste, or easy access to dental care.

This chapter will begin with an overview of the general situation of Indigenous health and disadvantage in Australia, including a discussion of the Close the Gap campaign, and will also delve briefly into Indigenous understandings of health to provide some cultural context. We will then move on specifically to the topic of oral health amongst the

¹ The term ‘Indigenous Australians’ includes Aboriginal people from across Australia as well as Torres Strait Islanders – the Torres Strait Islands are located between the tip of Cape York, the northernmost point of the state of Queensland, and Papua New Guinea

Indigenous community, including a discussion of the relevant social determinants. Three indicators will be used to assess the levels of Indigenous oral health in comparison to that of non-Indigenous Australians: caries, periodontal disease, and tooth loss. We will provide a brief summary of some of the barriers to attaining better standards of oral health, particularly in remote communities. Finally, we discuss what additional measures might be required if we are to make progress.

2. Closing the Gap: Indigenous disadvantage and health in Australia

In 2000, Commonwealth Minister for Health Dr Michael Wooldridge stated that Australia's 'single most spectacular failure as a nation has been in the area of Aboriginal and Torres Strait Islander health' (Jupp 2001). Such an acknowledgement in itself indicates progress. While the *National Aboriginal Health Strategy* received support from ministers back in 1990, it was never implemented fully (Thomson, 2003). Not until the mid-nineties did the government's involvement in Indigenous health even begin 'to approach the level required to address the persisting health disadvantages experienced by Indigenous people' (Thomson, 2003). As time goes by the issue of Indigenous health is receiving much more attention in politics, the media and the national collective consciousness. This section will first give a brief overview of the current situation of Indigenous health, and will then discuss the social determinants of Indigenous health in Australia. A quick introduction to Indigenous understandings of health will then be followed by a summary of the Close the Gap campaign.

2.1 The situation today

In terms of general health, Indigenous Australians suffer a significantly greater burden of disease than non-Indigenous people, yet they nonetheless have less access to health care than the rest of the population (AIHW, 2011). The Australian Indigenous population is a classic example of a non-Western society being highly susceptible to diabetes upon the introduction of a Western lifestyle (Irvine et al., 2003). They are often diagnosed later, are less likely to receive proper treatment, and are consequently more likely to die from cancer than non-Indigenous Australians (Thomson et al., 2010). Other conditions that impact on Indigenous people's greater burden of disease include kidney and respiratory diseases, rheumatic heart disease, and ear and hearing problems, while inadequate nutrition, alcohol consumption, smoking and the use of other drugs constitute the major risk factors impacting on the quality of life of Indigenous Australians (AIHW, 2011).

2.2 Social determinants

The current health status of Indigenous Australians is linked very closely to the social inequalities that many face (Thomson et al., 2010). These social inequalities are rooted in the experience of 'a history of conflict and dispossession, loss of traditional roles, failed assimilation and passive welfare' (Banks, 2007: 8) shared by many Indigenous groups around the world. The fact that such discrepancies in health status continue to this day, and that they are so overwhelming, is largely attributable to the social determinants of health – current structural and social circumstances (Thomson et al., 2010). Social determinants of Indigenous health include socioeconomic position (incorporating educational attainment, income, and employment), housing, transport (Carson et al., 2007) and racism.

2.3 Indigenous understandings of health

As we see in so many areas concerning Indigenous Australians, there is a lack of data regarding Indigenous understandings of health too, particularly those living in urban areas. We do know, however, that for the most part Indigenous Australians share a holistic understanding of the concept of health, with physical, mental, social, cultural and spiritual health all playing an important part (Commonwealth of Australia, 2007). The Standing Committee on Family and Community Affairs notes that Aboriginal society has 'no word, term or expression for 'health' as it is understood in Western society...The nearest translation in an Aboriginal context would probably be a term such as 'life is health is life'' (National Aboriginal Health Strategy Working Party, cited in Commonwealth of Australia, 2000: vii). As the Committee acknowledges, health disparities between Indigenous and non-Indigenous Australians can in part be attributed to the lack of culturally-appropriate access to health care for Indigenous people - many of the difficulties can be explained by these differing views of health, how to define it, and which services are necessary (Commonwealth of Australia, 2000). This approach differs from Western medicine which tends to separate body, mind and society - but this is not to say that the two approaches are mutually exclusive. It is also important to emphasise the variety of beliefs that occurs between the people of different parts of Australia (Maher, 1999). Health, from an Indigenous perspective, is a concept that incorporates:

everything important in a person's life, including land, environment, physical body, community, relationships and law. Health is the social, emotional, and cultural well-being of the whole community and the concept is thus linked to the sense of being Indigenous (Queensland Aboriginal and Islander Health Forum, cited in Burns et al., 2010).

2.4 The Close the Gap campaign

The National Indigenous Health Equality Campaign was developed in March of 2006, and the following year launched the name *Close the Gap* for its public awareness campaign. This came in the wake of 2005's Social Justice Report which called for state and national governments to commit to achieving equality for Indigenous people in health and life expectancy within 25 years. To demonstrate the major problem areas for Indigenous disadvantage, the Council of Australian Governments (COAG) set six targets over 2007-2008 towards 'Closing the Gap': it chose to focus on reducing the disparities in life expectancy, young child mortality, reading, writing and numeracy, employment, early childhood education, and secondary school completion (Steering Committee for the Review of Government Service Provision, 2009), so it is clear that health disparities occur within a context of general inequality.

The campaign has brought together many health organisations (both Indigenous and non-Indigenous), including the Indigenous Dentists' Association Australia, as well as human rights groups. Probably the strongest messages conveyed to the public through this campaign include the fact that Indigenous Australians will die up to 17 years earlier than other Australians, and that access to basic health care facilities continues to be very limited (Oxfam Australia, 2010). We are seeing an increased commitment now, with the Federal government signing the Close the Gap Statement of Intent in March 2008, COAG's commitment, and the announcement in late 2008 that the Australian Government would commit the unprecedented sum of AU\$1.6 billion towards improving Indigenous health (Oxfam Australia, 2010). This is of course a welcome response, but the National Partnership Agreement makes no mention of oral health, an area that often seems to go ignored.

3. Indigenous oral health

The World Health Organisation defines oral health as 'being free of chronic mouth and facial pain, oral and throat cancer, oral sores, birth defects such as cleft lip and palate, periodontal disease, tooth decay and tooth loss, and other diseases and disorders that affect the mouth and oral cavity' (WHO, 2007). Following on from this, another definition emphasises the fact that a satisfactory standard of oral health will allow an individual to 'eat, speak and socialise without active disease, discomfort, or embarrassment and which *contributes to general wellbeing*' (Dental and Ophthalmic Services Division, 2005, emphasis added). The body of evidence linking oral health to other conditions only continues to grow (Guynup, 2006), demonstrating the importance of oral health as an important public health issue. Unsurprisingly, tooth loss and pain will often restrict eating and can result in weaker nutritional intake, which in turn can be associated with anaemia and gastrointestinal disturbances. Infection and tooth loss often result from poor oral health, and in addition to causing pain they can impede speaking and therefore have an impact on social interaction (Mason et al., 2006). More complex relationships link oral infection to systemic disease, for example arteriosclerosis, cardiovascular disease (Ylöstalo et al., 2006), diabetes (Taylor, Bornakke, 2008), stroke (Joshipura 2003), pre-term and low birth weight babies (Xiong et al., 2006), pulmonary diseases, and disorders such as otitis media and delayed growth and development. Likewise, recent studies have found associations between diseases like arthritis, diabetes, HIV and osteoporosis, and oral, dental and craniofacial diseases and disorders (Slavkin, 2000).

The ramifications of poor oral health can be immense, and are felt much more by Indigenous Australians than non-Indigenous people - Indigenous people have more caries, periodontal disease, and tooth loss than other Australians and, given that problems are more likely to go untreated, are also more likely to have teeth removed (Williams et al., 2011). It is important to note that it is likely that levels of oral disease amongst Indigenous Australians are in fact under-reported (Bazen et al., 2007b).

Many oral health problems suffered by Indigenous Australians share risk factor characteristics with wider general health problems. This means that while a great deal of work needs to be done, we can choose to see this as an opportunity to create positive change - efforts to encourage healthy eating, for example, are likely to have a positive impact not just on the oral health of the community but could also lead to reduced incidence of heart disease, obesity, and anaemia. An oral health campaign around links with drinking alcohol and smoking could have ramifications not just on oral health, but rates of lung cancer and emphysema. Such associations mean that the potential benefits of improvements in Indigenous oral health could extend to have numerous other health benefits, and as we learn more about these links our capacity to improve the situation will only increase. Improved information and understanding of oral health and dental care for this group is absolutely essential for the development and implementation of informed, effective public health policy.

There are numerous challenges arising from the lack of data on Indigenous health, particularly oral health. A large proportion of the available information focuses on specific communities or regions rather than giving an overall picture of the national situation. With wide variations in study design, it is not possible to accurately compare statistics taken in the past to those acquired more recently - before a complete understanding of the oral health status of Indigenous Australians can be attained, there is a great need for further epidemiological information (Williams et al., 2011).

3.1 Experience of oral health impairment

Caries, periodontal diseases and tooth loss all provide visible, quantifiable evidence of oral ill-health, but the experience of pain, oral functioning and quality of life are also very important. People's experience of food avoidance because of dental problems, perceptions of their oral health, and experience of toothache provide additional insights into the oral health of Australians. The *National Survey of Adult Oral Health* (NSAOH) included qualitative questions to assess the experience of oral health impairment.

Poor oral health can cause people to avoid certain foods, which may limit a person's enjoyment of food and their ability to maintain a balanced diet (Slade et al., 2007). Indigenous adults were twice as likely as non-Indigenous adults to report avoiding foods due to oral health problems, with the highest difference in those aged 35-54 years (49% of Indigenous people and 17% of non-Indigenous people).

In responses to the NSAOH, Indigenous people were 1.5 times more likely than non-Indigenous people to rate their oral health as 'fair' or 'poor' (the two lowest measures) (Slade et al., 2007). Indigenous adults aged 35-54 years were twice as likely as their non-Indigenous counterparts to provide this rating.

Toothache can be caused by dental diseases, related infections, broken teeth, or nerve sensitivity (largely due to contact with hot or cold food or drinks). Toothache ranges from a short-term mild sensation to persistent, disabling pain. Data on the frequency of toothache collected in the NSAOH identified that Indigenous people were 1.8 times more likely than non-Indigenous people to report toothache in the previous year (27% compared with 15%) (Slade et al., 2007). The largest difference was seen for those aged 35-54 years: 39% of Indigenous people and 15% of non-Indigenous people reported toothache.

This section will discuss the current state of Indigenous oral health in comparison to that of non-Indigenous Australians using three main indicators: caries, periodontal disease, and tooth loss. It will also consider other conditions resulting from poor oral health. Caries and periodontal disease are both easily preventable, as well as being curable within the initial stages. We will then move on to present information on some of the barriers to good oral health for Indigenous communities across Australia.

4. Caries

Dental caries (cavities or tooth decay) is caused by acid-producing bacteria that exist in the oral environment. These bacteria proliferate in the presence of sweet and sticky foods (Harford et al., 2003). In the early stages dental caries can be completely reversed, but when left untreated it may cause irreversible damage such as cavitation of tooth enamel. Small cavitations do not generally produce ongoing pain and require small restorations (fillings). Larger carious lesions, however, can completely undermine the structural integrity of the tooth. These often require substantial restorative treatment or extraction, particularly if the lesions extend to the dental pulp, resulting in pulpal infection, pulpal inflammation and pain. Pulpal inflammation is one of the most common reasons for attendance at the dentist (Williams et al., 2011). It can be reversible up until the carious lesion reaches the pulp, but once it does it is more likely to be irreversible (Abbott & Yu, 2007). The treatment protocol for long-standing irreversible pulpal inflammation is root canal therapy or extraction (Yeng et al., 2007). Long-standing pulpal inflammation will result in pulp necrosis. As pulp necrosis causes loss of the tooth's sensory apparatus, the dental pain associated with the initial inflammation completely subsides. Many patients at this point will assume the

problem has improved or healed itself, but infection of the dental pulp may continue to spread through the apex of the pulp canal/s into the supporting structures, causing periapical periodontitis (Abbott & Yu, 2007). This may result in severe pain and often systemic effects (e.g. fever). Patients with periapical periodontitis require root canal treatment or extraction. If the tooth is to be restored, the remaining decay usually requires substantial extra coronal restoration (i.e. crowns). Both the root canal therapy and the crown are expensive, and this type of treatment from a private practitioner may cost more than one thousand Australian dollars. If specialists are performing the treatment it will likely be more.

Such costs present an insurmountable barrier to many patients, particularly the socially and financially disadvantaged. If the patient is treated in the public sector, whilst the cost is substantially less, the waiting lists are large in some jurisdictions and treatment options are usually restricted by policy. As extractions tend to cost a few hundred dollars in the private sector and tens of dollars in the public sector, it is no surprise that many disadvantaged patients (including Indigenous Australians) opt for extraction, rather than other treatments. Most public dental providers in Australia do not offer root canals or crowns. Whilst extraction may provide quick relief of pain, there are long-term consequences that may need to be addressed later on. For instance, masticatory efficiency diminishes as teeth are lost. If a patient has many extractions they may require dentures. In the private sector dentures may cost upwards of a thousand dollars. In the public sector they cost hundreds of dollars, but there may be a further waiting list. For instance, in 2010, South Australia had approximately a two-year waiting list for treatment in the public dental sector. The waiting list for dentures, however, was about four years.

Caries is a major health concern and if not prevented may have painful and difficult consequences. Regardless of the extent of the disease and the required treatment modality, all of the options will have life-long consequences and require maintenance/treatment even if a tooth is lost. As such, increased policy and interventions aimed at the prevention of dental caries would be cost-beneficial.

Caries experience is measured by the Decayed Missing and Filled Teeth (DMFT) index for permanent (adult) teeth or by the dmft index for deciduous (juvenile) teeth. Both indices measure how many teeth (T/t) are decayed (D/d), missing due to caries (M/s) or filled due to caries (F/f). Neither index differentiates between a tooth with minor problems and one with major problems, nor do they provide a direct indication of the discomfort or dysfunction experienced.

To get a more accurate picture of decay, another index, the Decayed Missing and Filled Surfaces (DMFS) is used. By measuring the number of decayed/missing/filled surfaces on each tooth, rather than the tooth as a whole, the DMFS provides more detail about an individual's caries experience. It is also important to note that the DMFT/dmft and DMFS/dmfs indices are cumulative: once a tooth has experienced caries it is permanently recorded by the index. As a result, these indices provide information about caries experience over a lifetime and cannot account for changes in risk factors or active disease levels.

It should also be noted that these indices do not measure the effect of caries experience on quality of life, which can be significant. It is important to understand this relationship, and so several instruments have been developed to measure the effect oral health has on quality of life. The Oral Health Impact Profile (OHIP) is one such index (Slade & Spencer, 1994). The shortened version, OHIP-14, contains fourteen questions that address the effect of oral health on a subject's life, for instance, recent pain levels or disruptions to sleep.

4.1 Caries among Indigenous children

Indigenous children experience more caries than non-Indigenous children in their deciduous teeth (Jamieson et al., 2007). According to the *Child Dental Health Survey* conducted in 1999, the mean number of decayed, missing, and filled deciduous teeth (dmft) in Indigenous children aged 4–10 years who attended a school dental service clinic was significantly higher than for their non-Indigenous counterparts in NSW, SA and the NT (Armfield et al., 2003). The highest dmft scores were for Indigenous six-year-olds, who experienced 2.4 times the dmft of non-Indigenous children of that age.

Four-year-old Indigenous children had more than three times the dental disease experience of their non-Indigenous counterparts. The highest numbers of missing teeth occurred in five-year-old Indigenous children, with a level more than five times that of non-Indigenous five-year-olds. The highest number of filled teeth occurred in eight-year-old Indigenous children. Taken together, the dmft scores indicated much poorer oral health in the deciduous dentition of Indigenous children aged 4–10 years than of their non-Indigenous counterparts, with the largest differences in the younger age groups.

Poorer oral health for Indigenous children continues among those with permanent teeth: the DMFT² was 1.5 times greater for Indigenous children aged 6–15 years than for their non-Indigenous counterparts, with higher DMFTs for each increasing age group. Indigenous children had higher numbers of permanent teeth with untreated decay, with those aged 15 years having almost three times the average number of their non-Indigenous counterparts. Numbers of filled teeth were similarly higher for Indigenous children, with six-year-old Indigenous children experiencing twice the number of filled teeth than non-Indigenous six-year-olds.

Age (years)	Indigenous	Non-Indigenous
6	8	3
7	14	10
8	24	14
9	29	17
10	38	21
11	37	25
12	45	29
13	46	31
14	59	39
15	62	58
16	67	59
17	73	61

Note: 1 Data are for 12-month periods: NSW from 2000; SA from 2003; and the NT from 2002
2 Where children had more than one examination, information from the first examination has been used

Table 1. Proportions (%) of children aged 6–17 years with DMFT>0, by Indigenous status and age, New South Wales (NSW), South Australia (SA) and the Northern Territory (NT), 2000–2003
Source: Jamieson, Armfield & Roberts-Thomson, 2007

² The numbers of missing permanent teeth of children aged 6–15 years were negligible

Where children live affects their experience of caries, with caries more common in rural and remote settings than in metropolitan centres (Jamieson et al., 2007a). According to the *Study of Aboriginal and Torres Strait Islander child oral health in remote communities*, Indigenous children living in rural areas had higher dmft and DMFT scores than Indigenous children in metropolitan areas, and non-Indigenous children in both rural and metropolitan areas had similar oral health, with levels of decayed, filled and missing teeth, deciduous and permanent, lower than among Indigenous children. Cariogenic food products are easily available in metropolitan, rural, and remote communities and, as such, consumption patterns can be considered fairly constant.

Fluoridation of water supplies in metropolitan and many rural areas is fairly consistent, however many remote communities do not have access to artificially fluoridated water, although some naturally occurring fluoride may exist. It is likely that differing levels of water fluoridation are implicated in caries levels. Although water fluoridation has been shown to be an effective method for reducing the prevalence of dental caries, patterns of consumption and distribution of fluoridated water vary across Australia. Fluoridation alone cannot totally negate the effects of poor oral hygiene and highly cariogenic diets. Whilst the increase in caries among Indigenous children in remote communities may be associated with decreased water fluoridation, in light of the widespread availability of cariogenic food, it is likely that reduced access to oral care and oral hygiene education may be important factors in the caries rates of remote Indigenous children. Appropriate oral care includes the use of fluoridated toothpaste twice a day. Fluoridated toothpastes are an important part of preventing decay, however in areas without optimally fluoridated water supplies, the use of fluoridated toothpaste becomes more important. The SDS provides annual community visits, but many Indigenous children either are not enrolled in schools or are not present on the day of the visit, and miss the professional care benefits offered by this mainstream service.

Rates for hospital dental care were similar for Indigenous and non-Indigenous children living in metropolitan and rural areas, with rates for children living in rural areas 1.3 times higher than those for children living in metropolitan areas (Jamieson et al., 2007a). The higher rates in rural areas reflect the limited oral health services in these locations. The high rate of extractions in rural areas suggests that either more children in rural locations had unsalvageable teeth or that the delay for another appointment would be unreasonable if restorative treatment was unsuccessful.

The age pattern of hospitalisation for dental care was quite different for Indigenous and non-Indigenous children: more than one-half (51%) of Indigenous children were less than five years of age compared with around one-third (34%) of non-Indigenous children (Jamieson et al., 2007a). Only one-tenth of Indigenous children hospitalised for dental care were aged 10-14 years, compared with more than one-quarter (27%) of non-Indigenous children. Hospitalisation for younger children is usually sought when gross caries results in a need for several or many extractions. In these cases it is done under general anaesthesia in one appointment so as to reduce trauma for the child.

The more uniform distribution of the rates and proportions, as well as the age pattern of hospitalisation for dental care suggests that young Indigenous children had more advanced tooth decay in their deciduous teeth, or had a higher number of deciduous teeth that were affected and required extraction, than did young non-Indigenous children (Jamieson et al., 2007a).

Age group	Indigenous		Non-Indigenous		Rate ratio
	Proportion (%)	Rate	Proportion (%)	Rate	
<5 years	51%	907	34%	657	1.4
5-9 years	39%	667	39%	721	0.9
10-14 years	10%	181	27%	501	0.4

Table 2. Proportions and rates of children receiving hospital dental care, by Indigenous status and age group, and Indigenous: non-Indigenous rate ratios, Queensland, Western Australia, South Australia and the Northern Territory, 2002-03
Source: Jamieson, Armfield & Roberts-Thomson, 2007

Note: 1 Rates are per 100,000

2 Rate ratio is the Indigenous rate divided by the non-Indigenous rate

The overall rate of hospitalised dental extractions was slightly higher for Indigenous children than for non-Indigenous children, with the rate for Indigenous children less than 5 years of age more than twice that of their non-Indigenous counterparts (Jamieson et al., 2007). Tooth restoration rates were 1.3 times higher for Indigenous children aged less than 5 years than for their non-Indigenous counterparts, but Indigenous children of all ages were less likely than other children to have pulpal and ‘other’ treatments.

Increased referral rates for hospitalisation might also be indicative of a lack of cultural awareness amongst dentists treating Indigenous Australians. The experience at Pika Wiya Health Service Inc. in Port Augusta has shown that increased cultural sensitivity has resulted in improved oral health outcomes (Parker et al., 2005). The Western Australia Review has also described oral health services for Indigenous Australians in WA. In light of a decreasing labour market, the Centre for Rural and Remote Oral Health (CRROH) has described sustainable models for servicing rural and remote Indigenous populations that include culturally-sensitive education programs and the training of Aboriginal Health Care Workers (Kruger at al., 2010; Pacza et al., 2001; Bazen et al., 2007). CRROH has also been involved in pre-graduate placements for dental students in the region (Bazen et al., 2007).

4.2 Caries among Indigenous adults

Caries is much more common among Indigenous adults than among non-Indigenous adults (Slade et al., 2007). According to the NSAOH, Indigenous adults were 2.3 times more likely to have untreated caries than the non-Indigenous adult population, and 57% of Indigenous adults had one or more teeth with untreated decay compared with 25% of non-Indigenous adults (Slade et al., 2007).

The severity of decay suffered by Indigenous adults is also notably higher than that experienced by non-Indigenous adults (Slade et al., 2007). According to the NSAOH, Indigenous people 15 years and older had more than three times the number of decayed tooth surfaces than their non-Indigenous counterparts. The greatest difference was in the 35-54 years age group, with Indigenous people experiencing more than five times the decayed tooth surfaces than their non-Indigenous counterparts.

Almost four-fifths (78%) of Indigenous people aged 17-20 years included in the ABC Study were found to have caries, a level 1.2 times that documented for non-Indigenous people of that age group who participated in the NSAOH (Jamieson et al., 2010a).

Data from a large Western Australian retrospective study paints a less favourable picture of the oral health of Indigenous Australians. It calculated an average DMFT score of 8.5, four times higher than the NSAOH DMFT for the general population (Smith et al., 2007).

	Indigenous		Non-Indigenous		Ratio
	Prevalence	Confidence Interval (95%)	Prevalence	Confidence Interval (95%)	
Caries	78	74–82	63	51–73	1.2
Decayed teeth (DT>0)	74	70–79	23	15–34	3.2
Missing teeth (MT>0)	52	47–57	21	12–34	2.5
Filled teeth (FT>0)	23	19–27	49	38–61	0.5

Note: 1 Indigenous data from ABC study (2006-2007) and non-Indigenous data from the NSAOH (2004-2006)
2 Prevalence is percentage of people with the condition; confidence interval provides an indication of the reliability of the estimated prevalence
3 Ratio is the Indigenous prevalence divided by the non-Indigenous prevalence

Table 3. Prevalence of caries-related conditions, by Indigenous status, and Indigenous-non-Indigenous ratios, Australia, 2004-2007
Source: Jamieson, Sayers & Roberts-Thomson, 2010a

	Indigenous		Non-Indigenous		Ratio
	Prevalence	Confidence interval (95%)	Prevalence	Confidence interval (95%)	
DMFT	4.8	4.3–5.3	2.8	1.8–3.8	1.7
Decayed teeth (DT)	4.1	3.7–4.5	0.5	0.3–.07	8.2
DMFS	8.3	7.2–9.4	3.2	2.1–4.3	2.6
Decayed surfaces (DS)	7.6	6.5–8.7	0.7	0.3–1.0	10.9
Filled surfaces (FS)	0.7	0.5–0.9	2.6	15. –3.7	0.3

Note: 1 Indigenous data from ABC study (2006-2007) and non-Indigenous data from the NSAOH (2004-2006)
2 Prevalence is percentage of people with the condition; confidence interval provides an indication of the reliability of the estimated prevalence
3 Ratio is the Indigenous prevalence divided by the non-Indigenous prevalence
4 See text for details of DMFT

Table 4. Mean caries scores, by Indigenous status, and Indigenous-non-Indigenous ratios, Australia, 2004-2007
Source: Jamieson, Sayers & Roberts-Thomson, 2010a

Indigenous people aged 17-20 years had 3.2 times the prevalence of decayed teeth and 2.5 times the prevalence of missing teeth than did their non-Indigenous counterparts. On the other hand, the level of fillings was lower among Indigenous people than among non-Indigenous people: the ratio for filled teeth was 0.5 and for filled surfaces was 0.3. Together with their higher decay rates, these ratios suggest that service utilisation was lower – and levels of untreated caries substantially higher – among this Indigenous population than among same-aged non-Indigenous people who participated in the NSAOH.

A comparison of the mean number of decayed teeth and surfaces (severity) reveals the same trends. Indigenous people aged 17-20 years experienced 1.7 times the mean number of decayed, missing, or filled teeth than their non-Indigenous counterparts (Jamieson et al., 2010a). When broken down into its components, this group experienced 8.2 times the prevalence of decayed teeth. When using the DMFS compared to DMFT, the mean number of decayed, missing, or filled teeth compared to surfaces increased from 1.7 to 2.6, and the mean number of decayed teeth compared to surfaces increased from 8.2 to 10.9.

4.3 Protective and risk factors for caries

Diet

Caries can largely be prevented by maintaining a healthy diet (Harford et al., 2003). Since the arrival of Europeans in Australia in 1788, there has been a rapid change in diet for many Indigenous people from a fibre-rich, high-protein, low-saturated-fat, traditional diet to a diet high in refined carbohydrates and saturated fats (Australian Bureau of Statistics, 2008; Jamieson et al., 2006). This new diet includes a lot of processed and sugary foods and little fresh produce. This is especially true for people living in remote areas where food can be considerably more expensive than in urban areas (Queensland Health Treasury, 2006). Fresh produce may often be in poor condition after being transported long distances. Many Indigenous people, including children, consume a high level of sugary, cariogenic foods, such as carbonated drinks and confectionary (Jamieson et al., 2006). This non-traditional diet substantially increases the risk of caries.

Water fluoridation

The fluoridation of public water supplies is an effective way to prevent caries (Ehsani & Bailie, 2007). It is considered to be both the most cost-effective and socially equitable way of preventing dental decay and could significantly benefit communities that are socio-economically disadvantaged, such as remote Indigenous communities. National reports have documented that 20 percent of Australians, most of which live in rural areas, currently do not have access to fluoridated water (Australian Health Ministers' Advisory Council, 2001). These reports have recommended that water fluoridation should be extended to small rural communities. *Healthy mouths healthy lives: Australia's national oral health plan 2004-2013* suggests that water fluoridation should be made available to communities with populations less than 1,000 people (National Advisory Committee on Oral Health, 2004), and there is evidence to suggest that fluoridation may be cost effective in larger remote Indigenous communities (Ehsani & Bailie, 2007). Until fluoridation becomes available to all Indigenous people, they will continue to be at increased risk of dental decay. It should be noted that fluoridation of Brisbane's water supply has begun, and that by the end of 2012, 95% of the population will have access to fluoridated water. With the inclusion of Queensland in community water fluoridation statistics, the percentage of Australians lacking access to fluoridated water will continue to decrease (AIHW, 2002).

Oral hygiene

Good oral hygiene is fundamental in preventing caries. Self-care includes frequent tooth-brushing with fluoridated toothpaste and requires an understanding of the value of good oral care, as well as resources available to purchase toothbrushes and toothpaste (Jamieson et al., 2006). There is evidence that oral care practices were not necessary with a traditional

Indigenous diet, and were not part of some Indigenous cultures (Harford et al., 2003). There are also strong ties between socioeconomic status and oral hygiene with those who are more disadvantaged being less likely to practice good oral hygiene (Harford et al., 2003; Slade et al., 2007). Thus, for economic and socio-cultural reasons, Indigenous people are at increased risk of caries.

Professional dental care

Many professional dental services are not affordable for, or available to, Indigenous people (Harford et al., 2003). Few dental professionals work in rural or remote locations, and studies have found that private dental care is too costly for many Indigenous people. Similarly, many dental services are not culturally sensitive, thus creating access barriers for Indigenous people. Without professional dental care, Indigenous people are at increased risk of untreated dental decay.

Hypoplasia

Another important factor for the prevention of caries is having strong teeth from birth (Seow, 1997). Tooth enamel provides a hard, protective surface on the tooth. If the enamel becomes weak, a condition known as enamel hypoplasia may result in increased incidence of caries. Enamel hypoplasia can result from a congenital condition, premature birth, infections during childhood, malnutrition (Pascoe & Seow, 1994) and low birthweight (Lai et al., 1997), many of which occur at higher rates among Indigenous people than in the total population (Australian Health Ministers' Advisory Council, 2008).

5. Periodontal disease

Periodontal diseases are associated with bacterial infection of the periodontal (gum) tissues causing inflammation. Unlike caries, they are specifically attributed to poor oral hygiene as opposed to a poor diet, together with underlying host susceptibility. Like caries, periodontal disease is preventable and treatable. Periodontal diseases range in severity from gingivitis (a mild and completely reversible form) to periodontitis (a severe destruction of the tissues that support the teeth). Gingivitis is characterised by inflammation and bleeding gums and can be completely cured. Symptoms of periodontitis include the loss of tooth-supporting bone and the formation of periodontal pockets (spaces between the gum and tooth), and clinical attachment loss, where bacteria have caused the deterioration of bone and ligament. Periodontitis can result in tooth mobility, partial and total edentulism (loss of all teeth), and halitosis. Most forms of periodontitis do not cause pain, although some forms, namely Acute Necrotising Ulcerative Gingivitis and Acute Necrotising Ulcerative Periodontitis, do cause significant pain. Periodontitis can be localised (to a few teeth) or generalised (to larger areas of the mouth, or the whole mouth). It is predominantly chronic, and may begin in the early 20s age group. However, research suggests that it is typically a disease of ageing and usually occurs later in life (Pihlstrom et al., 2005). Acute forms exist, however these are rare and tend to occur in patients with complicating systemic factors. Acute forms also tend to be localised. Periodontitis risk factors include smoking, diabetes, stress, genetic and epigenetic inherited factors, hormonal imbalance, immunosuppression, maleness, mouth breathing, low socio economic status (SES), poor education, and poor nutrition. As Indigenous Australians are more likely to smoke, have diabetes, have poor nutrition, are typically lower on the SES ladder, and may be at an increased genetic risk (not

yet supported directly by the literature), they are likely to be at an increased risk of developing periodontal disease.

Indices exist to measure periodontal disease, however definitions about what to include in an index are contentious, and the use of different definitions has resulted in a wide range of prevalences within the same populations.

As with caries, these indices do not measure the effect of periodontal disease on quality of life. Once again, measures like OHIP are useful to gauge the effect of disease on quality of life.

5.1 Periodontal disease among Indigenous children

Children rarely develop severe periodontal disease, but gingivitis is relatively common on the gums of Indigenous children around both deciduous and permanent teeth, especially for older children. Although gingivitis in itself does not cause destruction of periodontal structures, it is inflammation nonetheless and should be prevented. Periodontitis is an exacerbation of gingivitis, however the progression from gingivitis to periodontitis is not certain and only occurs in individuals at risk. Furthermore, the prevention of gingivitis, appropriate oral hygiene, decreases the likelihood of developing dental caries. According to the *Study of Aboriginal and Torres Strait Islander child oral health in remote communities*, the prevalence of gingival bleeding, a common symptom of gingivitis, was higher for Indigenous children aged 6-15 years in South Australia than for their non-Indigenous counterparts (Jamieson et al., 2007a). The level of gingival bleeding among Indigenous five-year-olds was almost four times higher than that among non-Indigenous children of the same age. Among 12 year-olds, almost one-half (48%) of Indigenous children had gingival bleeding compared with 23% of non-Indigenous children. The same study found that gingival bleeding was common among Indigenous children in New South Wales. Indigenous children aged 12-14 years had a markedly higher prevalence of bleeding than did their non-Indigenous counterparts, but there was little difference in prevalence between Indigenous and non-Indigenous children 4-12 years. Three-in-five Indigenous children living in remote communities showed some evidence of gingivitis and approximately one-in-five children were at moderate risk of developing gingivitis. More than two-fifths (42%) of Indigenous children aged 15-16 years were at moderate risk of developing gingivitis and 25% were at high risk.

5.2 Periodontal disease among Indigenous adults

Indigenous adults are more likely to suffer from periodontal disease than their non-Indigenous counterparts (Slade et al., 2007). According to the *NSAOH*, almost 27% of Indigenous people 15-74 years had gingivitis; they experienced approximately 1.3 times the prevalence of moderate and severe periodontitis than did their non-Indigenous counterparts. Indigenous people had a slightly higher prevalence of deep (4+mm) periodontal pockets and clinical attachment loss than did non-Indigenous people.

An *ABC-NSAOH* comparison of Indigenous and non-Indigenous people aged 17-20 years demonstrates a more notable difference in periodontal diseases between the two groups: Indigenous people had 1.7 times the prevalence of calculus deposits (a risk indicator of periodontal diseases), 1.2 times the prevalence of gingivitis, 9.5 times the prevalence of moderate or severe periodontal disease, and 11.8 times the prevalence of deep periodontal pockets than did their non-Indigenous counterparts (Jamieson et al., 2010a).

Indigenous people are affected by periodontal diseases at much younger ages than non-Indigenous people (Harford et al., 2003; Armfield et al., 2003; Gracey, 2000). According to the *NSAOH*, Indigenous people aged 15-34 years experienced almost twice the prevalence of moderate or severe periodontitis than their non-Indigenous counterparts (13.5% and 7.3% respectively) (Slade et al., 2007). Compared to non-Indigenous people aged 15-34 years, Indigenous people in the same age group had higher prevalences of deep periodontal pockets (18% compared with 13%), clinical attachment loss (24% compared with 17%), and tooth sites with deep periodontal pockets (1.3% compared with 0.6%).

	Indigenous		Non-Indigenous		Ratio
	Prevalence	Confidence interval (95%)	Prevalence	Confidence interval (95%)	
Calculus deposits	89	86-92	52	41-63	1.7
Gingivitis	89	86-93	74	65-82	1.2
Periodontal pockets 4mm or deeper	61	57-66	5.2	2.3-11.5	11.8
Moderate or severe periodontal disease	27	19-35	2.8	0.8-8.9	9.5

Note: 1 Indigenous data from *ABC* study (2006-2007) and non-Indigenous data from the *NSAOH* (2004-2006)
2 Prevalence is percentage of people with the condition; confidence interval provides an indication of the reliability of the estimated prevalence
3 Ratio is the Indigenous prevalence divided by the non-Indigenous prevalence

Table 5. Prevalence of periodontal risk indicators and periodontal diseases, by Indigenous status, and Indigenous: non-Indigenous ratios, Australia, 2004-2007
Source: Jamieson, Sayers & Roberts-Thomson, 2010a

5.3 Protective and risk factors for periodontal diseases

Smoking

Smoking is a significant risk factor for the development, progression and severity of periodontal diseases (Do et al., 2008). According to the *2004-2005 National Aboriginal and Torres Strait Islander health survey*, one-half of the adult Indigenous population smoked daily or regularly, a level more than twice that of non-Indigenous adults (Australian Bureau of Statistics, 2006).

Diabetes

Diabetes, especially uncontrolled or poorly controlled diabetes, is associated with increased risk of oral infections (Harford et al., 2003). Diabetes/high sugar levels were reported by around 6% of Indigenous people who participated in the *2004-2005 National Aboriginal and Torres Strait Islander health survey* (Australian Bureau of Statistics, 2006). After adjusting for differences in the age structures of the two populations, diabetes/high sugar levels were around 3.4 times more common for Indigenous people than for non-Indigenous people. A 1998-2000 study of periodontal diseases among diabetic and non-diabetic residents of the Anangu Pitjantjatjara lands in South Australia found that Anangu people with diabetes were more than three times as likely as those without diabetes to have 4-5 mm periodontal pockets and almost 10 times as likely to have 6+mm pockets (Endean et al., 2004).

Oral hygiene

Periodontal diseases are also attributed to poor oral hygiene, in which self-care plays an important role. According to the *Study of Aboriginal and Torres Strait Islander child oral health in remote communities*, less than one-fifth of Indigenous children living in remote communities in New South Wales, South Australia and the Northern Territory brushed their teeth at home (20%) or at school (18%), and less than 5% of those younger than five years of age brushed their teeth regularly (Jamieson et al., 2007a). A study in the Top End of the Northern Territory in 2003 found low levels of regular preventive oral health care among remote Indigenous children (Jamieson et al., 2006). The study noted that about 84% of the children in the study used a toothbrush, but only 20% used toothpaste on a daily basis. The use of toothpaste generally started relatively later in life, with the most common commencement age being four years. This may reflect commencement of pre-school and exposure to oral hygiene strategies organised by schools. Children learn their oral self-care habits from seeing what other people do on a daily basis; caregivers who regularly partake in oral self-care habits, such as brushing and/or flossing, are likely to instil such behaviours in the children in their household (Mattila et al., 2001).

Professional dental care

Professional dental care is also important in periodontal health (Pihlstrom et al., 2005). According to the *NSAOH*, fewer Indigenous adults than non-Indigenous adults reported visiting a dentist within the last twelve months (51% compared with 60%) (Slade et al., 2007). Similarly, Indigenous people were more than 20% less likely than non-Indigenous people to visit a dentist annually (43% compared with 53%).

Indigenous people face a number of barriers, including cost, to regular and timely professional dental care (Slade et al., 2007), and the course of periodontitis can be substantially worse for patients without regular access to dental care. Unfortunately, periodontitis and limited dental care (professional and self-care) can establish a 'vicious cycle': the onset of disease makes cleaning more difficult, and, as cleaning becomes more difficult, more acute and deeper bacterial invasion of the tooth surface worsens the level of disease. This cycle eventually results in destruction of the tooth-supporting apparatus and tooth loss.

6. Tooth loss

The main causes of tooth loss are extraction of diseased teeth due to dental caries, periodontal diseases, and trauma (Harford et al., 2003). Complete tooth loss, known as total edentulism, significantly affects oral functioning and quality of life. Tooth loss is overrepresented among Indigenous people and edentulism occurs at younger ages for Indigenous Australians.

6.1 Tooth loss due to injury

Injuries of the head and neck may affect dentition; fractures specifically of the maxilla and mandible are directly related to tooth loss and loss of function (Sclaroff et al., 2000). Fracture of the skull and facial bones, with associated tooth loss, is the third most prevalent head injury in Australia. Tooth loss due to head trauma can markedly reduce quality of life. After adjusting for differences in age, gender and residential location, the rate of hospitalised head

injury due to assault was 21 times higher for Indigenous people living in Queensland, Western Australia, South Australia and the Northern Territory in the six year period 1 July 1999 to 30 June 2005 than for their non-Indigenous counterparts. The rate ratio was especially high among females: 69 for all ages and 93 for the 30–34 years age group. Whilst this statistic is not specific for tooth loss or dental trauma, it is likely that in light of such high rates of facial trauma increased tooth loss also follows.

6.2 Edentulism

Edentulism reflects both extensive dental disease and past surgical approaches to the treatment of oral diseases that relied largely on extractions (Slade et al., 2007). Edentulism leads to poorer oral functioning and often to notable discomfort. Individuals missing all of their teeth must either endure with no teeth, which greatly affects a person's ability to eat, or choose to wear full dentures, which are generally uncomfortable and can lead to complications if not properly cleaned and maintained.

Edentulism is strongly correlated to age; in Australia less than 2% of adults aged 35–54 years have complete tooth loss but this increases to 36% for people aged 75 years or older (Slade et al., 2007). The age distribution of edentulism for Indigenous people is noticeably different from that of the total population. The level of complete tooth loss is almost five times higher among Indigenous people aged 35–54 years than among their non-Indigenous counterparts (7.6% compared with 1.6%). There was also a notable difference for those aged 55–74 years; 21% of Indigenous people suffer from edentulism compared with 14% of non-Indigenous people.

7. Barriers to good oral health among Indigenous people

For many Indigenous Australians there are numerous factors that hinder the maintenance of good oral health. Most of these are linked to socioeconomic disadvantage. They include the cultural and geographical accessibility of oral health services, diet, water fluoridation, living conditions, oral hygiene, the cost of dental care, and lower rates of school attendance for children. Another important issue is the differing understandings of health, as outlined previously. When little of this is understood by mainstream health providers, it is not surprising that this can also constitute a significant barrier. For children, it has been suggested that under-utilisation of the School Dental Service in the Northern Territory may well be a result of low school attendance in some communities, despite the fact the Service provides care to communities regularly (Jamieson et al., 2006).

7.1 Cultural accessibility of oral health services

For the most part, oral health services tend to stipulate certain rules that are not necessarily compatible with Indigenous culture, in addition to the fact that they ignore the Indigenous understandings of health. Barriers can include communication challenges where Indigenous patients do not speak English as their mother tongue, and a general unwillingness to allow patients to visit accompanied by family members or friends, something often important to Indigenous patients. The current lack of Indigenous dentists, dental therapists and other oral health professionals poses a problem given many Indigenous people may be more likely to visit an Indigenous dentist (Jamieson et al., 2008). While in general the staff of oral health services have no training in cultural sensitivity and no support in providing a more

appropriate service for Indigenous patients (Jamieson et al., 2008), efforts at the Oral Health Program at Pika Wiya Health Service in Port Augusta have demonstrated greatly increased acceptance of the service and improved attendance rates after the introduction of a culturally-sensitive oral health care service (Parker et al., 2005).

7.2 Geographical accessibility of oral health services

Australia is geographically one of the world's largest countries, with the vast majority of the relatively small population -89% - living along the coast and the vast interior being very sparsely populated. Considering around a quarter of Indigenous Australians live in remote parts of the country, the distance to the nearest dental clinic can be long, and even when transport is available the roads are often in poor condition (Australian Bureau of Statistics, 2008). For people living in urban areas, transport can also be an issue.

7.3 Diet

Again hinging on Australia's immense area, the transport of healthy foods to remote communities is a major issue and for this reason many Indigenous people can have very limited options in terms of their diet. The availability of many healthier food items (for example wholemeal breads, lean meat, reduced-fat milk, and fresh fruits and vegetables) tends to be erratic in the more rural and remote areas (Williams et al., 2011). Fresh foods in particular, when available, can cost up to 30 percent more than in urban parts of the country (Harrison et al., 2007). With limited range and very high prices, those living in rural and remote Australia are more likely to eat the more affordable foods available, often processed foods high in both sugar and carbohydrates. Such foods of course impact negatively on general and oral health.

7.4 Water fluoridation

The fluoridation of drinking water supplies has been lauded as 'the single most effective public health measure for reducing dental caries across the population, with its most pronounced effects among those who are disadvantaged and most at risk' (Acheson 1998, DHS 2000a) (Government of South Australia, 2004: 16). Fluoridation affords those members of the community lacking in financial resources to buy toothbrushes and fluoridated toothpaste access to fluoride in their water, and this can reduce caries by 20-40% (NHMRC 1991, Ahokas et al., 1999). However, rural and remote communities again tend to miss out here - in excess of 80% of remote-living Indigenous people lack access to fluoridated town-water supplies (Ehsani and Bailie, 2007).

7.5 Living conditions

Many Indigenous Australians live in sub-standard housing (Bailie, 2007), a condition strongly linked to higher levels of poor health and disease (ABS, AIHW, 2008). The factors that impact most on oral health include a lack of safe (let alone fluoridated) drinking water, poor sanitation, and overcrowding. A survey conducted in 2008 found 25% of Indigenous people over the age of 15 years were living in overcrowded housing (Australian Bureau of Statistics, 2009), and this has a direct effect on oral health (Jamieson et al 2010) in that the absence of a clean, safe place to store toothbrushes can discourage their use. Another important factor is the frequent movement between houses that many Indigenous Australians make, meaning they may not always carry oral health care products with them.

7.6 Oral hygiene

Poor oral health results in large part from a lack of oral hygiene. The limited availability of toothbrushes, toothpaste and floss certainly impedes the maintenance of good oral hygiene in some remote communities, but it seems probable that the importance of good oral hygiene is not always recognised by Indigenous people – overall their use of toothbrushes and fluoridated toothpaste is below suggested levels (Jamieson et al., 2006). Given the evidence that the traditional Indigenous diet before colonisation did not necessitate oral self-care, such practice has not featured in many Indigenous cultures (Harford et al., 2003).

7.7 Professional dental care

Medicare is the Australian government's program enabling free treatment for patients of public hospitals as well as free or subsidised treatment by certain medical practitioners. It does not include provisions for any preventive oral health services. While low-income earners are entitled to concessions for public dental treatment, oral health services are often out of reach for many Indigenous people as a result of their expense (Slade et al., 2007). The majority of dental surgeries demand payment on the day, and the National Survey of Adult Oral Health found that Indigenous people were 1.5 times more likely than non-Indigenous people to have difficulty paying even a modest AU\$100 dental bill.

7.8 The dental-medical divide

Traditionally, the dental and medical fields have tended to be viewed as completely separate entities. In Australia the two professions have evolved quite separately, and one of the drawbacks of this is 'a general public mostly failing to grasp that the oral cavity relates in dynamic fashion with the rest of our being' (Widdop, 2005). In recent years there has been growing recognition of the links between oral and systemic health, and as a result this disciplinary divide is slowly breaking down (Guynup, 2006). The body of research indicating these links continues to grow, and the connections surely have strong relevance for Indigenous Australians given their poorer health in many different areas, oral and otherwise. While this chapter focuses on improving oral health for Indigenous Australians, it does so with a strong emphasis on the need for an overhaul of Indigenous health in general. It also acknowledges that there may be benefits to be had from an increased awareness amongst the general public of the importance of oral health to general health. The connections between oral health and overall health also give us reason to be optimistic about the broader benefits that could come from effective measures to improve oral health amongst Indigenous Australians.

8. Conclusion

There are many issues contributing to the higher rates of caries, periodontal diseases, and partial and total edentulism experienced by Indigenous Australians, particularly the cultural, economic and geographical factors limiting their access to services. Both the Australian government and the dental sector have a responsibility to address the inequalities in oral health. Today some progress is being made and we are seeing more and more services created with the goal of reducing the gap – so far, however, no program has offered a comprehensive plan targeted at the entire Indigenous population, only certain communities within it. Of course all factors must be considered within the context of the

social determinants of oral health. In order to deliver results, any strategy must deal with the broad range of factors that continue to underlie Indigenous disadvantage in Australia, as well as providing a long-term plan capable of making progress even as the political and economic scenarios change (Thomson et al., 2010). A successful and sustainable approach will also require the input of Indigenous people and health organisations. While the rates of all kinds of diseases, oral and systemic, are on average much higher in the Indigenous community, we can choose to regard this as an opportunity rather than just a miserable state of affairs. Any targeted response to improve oral health for Indigenous Australians is likely to create much broader health benefits for the population, just as initiatives aimed at reducing the rates of diabetes or heart disease will most probably result in improved oral health.

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Oral Health Care - Prosthodontics, Periodontology, Biology, Research and Systemic Conditions

Edited by Prof. Mandeep Viridi

ISBN 978-953-51-0040-9

Hard cover, 372 pages

Publisher InTech

Published online 29, February, 2012

Published in print edition February, 2012

Geriatric dentistry, or gerodontics, is the branch of dental care dealing with older adults involving the diagnosis, prevention, and treatment of problems associated with normal aging and age-related diseases as part of an interdisciplinary team with other healthcare professionals. Prosthodontics is the dental specialty pertaining to the diagnosis, treatment planning, rehabilitation, and maintenance of the oral function, comfort, appearance, and health of patients with clinical conditions associated with missing or deficient teeth and/or oral and maxillofacial tissues using biocompatible materials. Periodontology, or Periodontics, is the specialty of oral healthcare that concerns supporting structures of teeth, diseases, and conditions that affect them. The supporting tissues are known as the periodontium, which includes the gingiva (gums), alveolar bone, cementum, and the periodontal ligament. Oral biology deals with the microbiota and their interaction within the oral region. Research in oral health and systemic conditions concerns the effect of various systemic conditions on the oral cavity and conversely helps to diagnose various systemic conditions.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Madeline Shearer and Lisa Jamieson (2012). Indigenous Australians and Oral Health, Oral Health Care - Prosthodontics, Periodontology, Biology, Research and Systemic Conditions, Prof. Mandeep Viridi (Ed.), ISBN: 978-953-51-0040-9, InTech, Available from: <http://www.intechopen.com/books/oral-health-care-prosthodontics-periodontology-biology-research-and-systemic-conditions/indigenous-australians-and-oral-health>

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