RESEARCH

477  The burden of head and neck cancer in Africa: the status quo and research prospects.

507  Root canal treatment in mandibular canines with two roots: a review of the literature and a report of three cases

514  Oral health status of sentenced offenders in KwaZulu-Natal province

*Sahelanthropus tchadensis: A fairly recent discovery in Chad... and a controversial status... lived some six to seven million years ago and the few fossils so far found show some hominid characteristics... small canines and a relatively forward position of the foramen magnum... perhaps a bipedal walker?... But no final consensus... could be an ancestor of both chimpanzee and homo. Research is continuing.
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It may well have been from the poison fang of the snake that the concept of the hypodermic needle and syringe developed, as has been debated before in this column (September 2017). Indeed snakes have long been associated with the healing profession and appear in many traditional designs of the badges and insignia of medical and dental organisations. An official emblem adopted by the American Dental Association in 1965 depicts the snake as a central theme. An enigmatic, perhaps even quixotic, association with teeth?

As with so many practices the relationship has its origin in Greek fables, for the snake was commonly used by ancient Greeks in healing rituals, also being allowed to crawl around amidst the sick and injured lying on the floor. The sacred snake was a constant companion to the Greek demi-god Asclepius, the god of Medicine, in fact a demi-god, as he was begotten as a liaison between the divine Apollo and a mortal woman. To his son, Apollo gave the gift of healing and the secret pharmacology of plants and herbs. Asclepius produced a wide family, two sons and four daughters and his descendants persevered in the art of healing... in fact the most famous of the “Asclepiads” is Hippocrates, he of the sworn Oath we all have taken.

Asclepius was worshipped at various sanctuaries, the most famous being Epidaurus. Amongst the impressive buildings was an underground labyrinth, thought to contain snakes. These intriguing creatures were impressive to symbolise regeneration as they were regarded as living both above and below ground, enabling them to know otherwise arcane secrets. Epidaurus has a 6000 seat amphitheatre, dating from 340 BCE, which is still in use today... but without the snakes!

And so the myth also reigns today with the healing professions recognising both Asclepius and the snake by incorporating a staff with the snake wrapped around, head at the top. This is the Rod of Asclepius. Of great relevance is that the snake is single... only one snake ascending the rod. Yes, a similar design has also survived from Greek mythology, but with two intertwined snakes on a short, winged rod... that is the Caduceus as carried by Hermes and is associated with commerce and negotiation... and also with printing.

Some medical and dental associations have (erroneously) used the Caduceus as their insignia, perhaps an unhappy choice for the healing and altruistic professions, given that the symbol implies commerce rather than empathetic succour for the ill and suffering. A quick check of the badges and letterheads of the Specialist Societies of our Association revealed that only the Orthodontic Society included reptilian designs... and correctly, used only one snake around a long staff without wings! The Asclepius Rod. Well done SASO!

Local folklore also involves a snake in caring for people... Nyami Nyami is the affectionate name for the Zambezi River God... (full name Nyama yamaninga ninga... meaning “pieces of meat”). Nyami Nyami has the head of a fish... and the body of a snake! The River God is reputed to have resisted the construction of the Kariba Dam by causing enormous floods, the greatest for hundreds of years! The legend has it that in times of hunger the River God would bare his belly and offer the Tonga tribe pieces to savour. A caring snake indeed.

Now... let the imagination flow for a while and dissect the construct of the Asclepius Rod... could the coiling of the snake around the rod represent the vast complex of interwoven aspects of Dentistry, all ultimately related to the central theme of The Tooth, represented by the rod itself? The papers in the September issue of the Journal embody the breadth of healing encompassed by the practice of Dentistry.

Whilst the emphasis may be practical clinical dentistry, the role of the practitioner extends far beyond the confines of the oral cavity. Integral to every encounter with a patient is the commitment of the Dentist to be alert to the widest implications of the health status of his/her client. An awareness that the mysteries of whatever Dental Reptiles are encircling the tooth, they should be uncoiled.
As many as 1 in 3 people suffer from dentine hypersensitivity. New Sensodyne Rapid Relief is clinically proven to deliver fast relief in just 60 seconds and long-lasting protection from dentine hypersensitivity, helping to bring everyday improvements to your patients’ lives.

We have a crisis... our members report that they are experiencing difficulties in obtaining licences for new, reconditioned or reinstallation of their X-ray equipment. The Directorate of Radiation Control at the National Department of Health has referred all further enquiries to the South African Health Products Regulatory Authority (SAHPRA). We have been informed by Directorate Radiation Control that due to the fact that the posts of both the Deputy Director: Ionising Radiation and the Deputy Director: Inspectorate are currently vacant, the licensing of all X-ray equipment for installation and use was suspended with immediate effect. No information is available on how long this untenable situation will last.

It is with great concern that we have written to Ms Portia Nkambule, the Acting Chief Executive Officer of SAHPRA. We have also copied Ms P Matsoso, the Director of Health and Dr M Mcuba of the National Department of Health, Oral Health Directorate, in the hope that we can secure a meeting and that some interim solution can be found.

Understandably this regrettable situation could cripple the dental industry! It is both a clinical and regulatory requirement that all dental treatment be preceded with a radiograph, an aid to diagnosis, the determination of risks and influencing the recommended treatment plan for the patient.

It would, therefore, be both irresponsible and clinically poor practice to manage dental diseases without proper diagnostic aids in the form of radiographs. Practitioners will not be able to make informed and appropriate diagnoses which could open them up to HPCSA complaints and/or litigation. In addition, patients will not be reimbursed by their medical schemes for images taken with unlicensed radiographic equipment.

At the same time, it is completely unconscionable to expect dentists to cease practising and prevent them from carrying out their chosen profession and helping the community at large. The situation is simply not sustainable and we urge SAHPRA and the Department to propose an interim measure that will allow dentists to obtain x-ray and imaging equipment and to have these installed and licenced within a stipulated timeframe which should be governed by SAHPRA’s expectation in terms of filling the vacant posts.

SADA has been at the forefront of educating and encouraging our members to comply with the current regulations regarding the Licensing and QA Inspection of Dental X-ray Equipment. Most practitioners have complied and all that is left is the Certification/Licencing. We are also concerned that SAHPRA did not see it fit to inform us, as a body whose membership is primarily dentists, of the current situation, leaving SADA to second guess what the matter could be in the light of the deluge of complaints and concerns we have been receiving on a daily basis from our members.

SADA worked tirelessly to get this matter resolved by putting pressure on Government and related parties as well as working with other stakeholders to deal with this matter. Our efforts did bear fruits as per below. Should our efforts have failed, and as an absolute last resort, SADA was more than willing to have seriously considered legal recourse.

Interim solution found!

“Where there is pressure, a path can be created” KC Makhubele. After engaging with the Directorate of Radiation Control as well as SAHPRA to urgently review the situation and put an interim measure in place to prevent crippling the dental industry, the matter has been attended to.

SAHPRA has appointed an Acting Deputy-Director, temporarily and the licencing of Dental X-Ray Products for use has commenced again since the 12th of September 2018. We have been assured that all outstanding dental licences that were in the system have now been issued.

Members are advised that any applicants who have not received licences yet should contact one of the following offices:

- Pretoria 012 395 9121
- Durban 031 307 2111
- Cape Town 021 957 7443

It will expedite matters if you are able to quote existing licence numbers, where applicable. Should you still have issues, please contact my office via Dr N Niranjani - NNiranjani@sada.co.za. We remain committed to dealing with member issues speedily.
The burden of head and neck cancer in Africa: the status quo and research prospects

ABSTRACT

Background
The increasing incidence of head and neck cancer (HNC) in Africa is mostly due to increasing smoking habits, westernization in lifestyle and diet, HIV/HPV and unfavourable fiscal policies for health.

Oral cancer potentially constitutes a notable fraction of the global cancer burden, particularly in developing Africa. A heterogeneity in the anatomy-based HNC nomenclature has resulted in underestimation of its incidence and significance worldwide.

Method
The global cancer statistics database (GLOBOCAN) was used to evaluate the combined data of cancer incidence in two subsets: a.) excluding HNC and b.) including oesophageal cancers (Upper Aerodigestive Tract Cancer: UADTC). Combined age standardized incidence rates (ASIR) of HNC and UADTC were analyzed using both regional and individual country-derived data.

Result
Frequency ranking of HNC in Africa increases dramatically when cancers from contiguous HN regions are evaluated, compared with considering oral cancer data alone.

UADTC and HNC ranked second and third in Africa, respectively. Similar trends were observed by global development index evaluation.

Conclusion
With the exclusion of a few urban regions, the diagnostic and treatment opportunities for HN/UADT cancers in sub-Saharan Africa are dismal.

Effective education and research efforts by local and international (non-) governmental agencies are urgently required to reduce the associated morbidities.

Keywords
Oral cancer burden, Africa, research, HNC, UADTC

1. INTRODUCTION

Cancer is a major public health problem and a leading cause of death worldwide. It was estimated that between 1975 and 1990, there was a 37% increase in cancer cases with an annual growth rate of 2.1%. By the mid-nineties, over 10 million new cases were diagnosed with up to 6 million reported deaths. It is expected that this figure would have doubled by 2020. Similar trends were observed in the GLOBOCAN 2008 database where approximately 60% mortality to incidence ratio was observed.

It was also observed that 56% and 64% incidence and mortality figures respectively were reported in the developing world where cancer prognosis tends to be worse, due to late stage presentation, limited human resources and poorer infrastructure. Most recently, global cancer incidence and mortality figures were reported to be 14 and 8.3 million respectively, showing a steady increase as earlier predicted.

Oral cancer, which can be described as a malignant neoplasia originating in the oral cavity or on the lip, ranks as the sixth most common cancer worldwide and as third in developing nations, with a high age standardized
mortality rate (ASMR) of 6.8 (per 100,000 persons per year) in Black men as compared with their White or Hispanic counterparts.

However, there is apparent under-reporting of cases in many countries in Africa due to lack of cancer registries, cancer control programmes, modern health infrastructure, access to healthcare, finances, educational levels and existing religious and cultural beliefs. In addition, most databases have considered cancer in various anatomical locations as different entities attracting separate consideration, albeit that the processes of squamous carcinogenesis in the UADT are biologically similar.

This pattern is also extended to cancers in the anatomically contiguous head and neck region and has resulted in ambiguity in nomenclature. For example, terminologies like ‘oral cancer’, ‘orofacial cancer’, ‘oropharyngeal cancer’, ‘head and neck cancer’, and ‘upper aerodigestive cancer’ have been used interchangeably to describe mainly malignant squamous tumours in the maxillofacial region. To be able to address these inconsistencies in anatomy-based nomenclature and to standardize the comparison of epidemiologic studies, it has been suggested that the rubrics of the International Classification of Disease (ICD-10) for oncology should be employed for cancers in the head and neck region.

The inherent heterogeneity in oral cancers and the potential direct extension of these lesions depending on the time of presentation deserve careful consideration, particularly in Africa where most patients present late. Besides, due to limited manpower most cancer cases involving the lip and oral cavity, nasopharynx, other pharynx, larynx, and upper oesophagus may be diagnosed by the oral and maxillofacial pathologist or general pathologist in most African countries.

Presenting the burden of oral cancer in a fragmented manner may not reflect its high importance. There is an urgent need for coordinated research amongst health governing bodies and policy makers especially in Africa where most cases are not accurately reported.

Low and middle income countries (LMIC) account for 80% of the worldwide cancer burden, but receive only 5% of the global financial resources for cancer care. Many countries in Africa are undergoing economic modernization resulting in major changes in diet and lifestyle, smoking, and in sexual behaviour, having a potential influence on infections such as Human Immunodeficiency Virus (HIV) and Human Papillomavirus (HPV).

The burden of infectious diseases like malaria, cholera, HIV and tuberculosis (TB) has been a focus in Africa, against a backdrop of an increasing burden of non-communicable diseases (NCDs) such as cancer. According to the World Health Organization (http://www.who.int) NCD factsheet in 2011, NCD-related mortality by 2030 will exceed the combined mortality of maternal and perinatal deaths from communicable and nutritional diseases.

This paper, using a quantitative/descriptive analysis of the IARC/WHO GLOBOCAN database (http://globo. iarc.fr), demonstrates that the combined burden of oral cancer in Africa is much higher than is often reported. This emphasizes the urgent need for further research into the true burden in the African continent.

2. MATERIALS AND METHODS

We reviewed secondary data archived by WHO and IARC in GLOBOCAN 2008 and 2012 global cancer statistics.

Age standardized incidence rates for cancers affecting different regions of the human body were documented and analyzed using quantitative statistical methods; and visualized using stacked bar graphs, pie charts and tables.

2.1. Database and data mining

The GLOBOCAN database available at IARC provides updates of age-standardized incidence, prevalence and mortality rates of major cancer types for 184 nations of the world. The data are available for both sexes. There is a continual effort to improve the quality of data and coverage, albeit figures may not be consistent over a prolonged period and may result in differences every update.

Hence the database may not be optimal for making time-course statistical inferences due to potential methodological differences between updates. Data are derived from national and regional sources using percentage data coverage, rates and frequencies. The mode of estimation is country-specific and the quality of data is dependent on the standard of information available locally.

Estimates are made where local sources are inadequate. Country-specific summaries of the burden of disease of any major type of cancer can be accessed using the “factsheet” option. Typically, this option generates basic statistical summaries about the eight commonest cancers as well as regional and country-specific data. In addition, an option for simple online analysis can generate additional visualization such as maps and graphs.

2.2. Combined incidences analysis

ASIR for contiguous regions of the oral and maxillofacial and head and neck structures were combined. The newly generated combined incidence was compared with the incidences of other major cancer types in the body, excluding non-melanoma skin cancer.

This was done for sixteen representative regions of the world as well as twelve specific countries which were selected to reflect the comparative differences between Africa and other regions of the world.

2.2.1. Head and Neck Cancer (HNC)

ASIR for cancers involving the lip and oral cavity, nasopharynx, other pharynx, and larynx (which are typically diagnosed by many oral and maxillofacial pathologists in the African diagnostic histopathologic settings) were combined to reveal the true burden of Head and Neck cancers in Africa (Figure 1, p479).
The combined ASIR of these four contiguous regions was termed “Head and Neck Cancer (HNC)”.15-17 A HNC burden map was also constructed using the online analysis function.

2.2.2. Upper Aerodigestive Tract Cancer (UADTC)
Considering that oral and maxillofacial pathologists sometimes diagnose oesophageal pathological lesions as well, a second subset was created which included cancerous lesions of the oesophagus.

The five regions included in this subset were lip and oral cavity, nasopharynx, other pharynx, larynx and esophagus (Figure 1, above).

This subset was termed “Upper Aerodigestive Tract Cancer (UADTC)”.18-21 The online analysis function was used to construct a UADTC burden map.

2.3. Statistical analysis
Data was extracted from the GLOBOCAN website and saved in spreadsheets (Microsoft Excel version 2010).

HNC and UADTC combinations were performed in separate worksheets. For regional and country-specific analysis, pie charts and stacked bar graphs were constructed using the same version of Microsoft Excel.

The combined ASIR of HNC and UADTC in African regions and countries were compared with those of other more developed parts of the world. The proportions of the burden of HNC and UADTC compared with all other cancers were evaluated using stacked bar graphs.

2.3.1. Regional ranking
Sixteen regions were examined to assess how the combined ASIR of HNC and UADTC performed globally. Continental regions (n=4) included were: Africa, Europe, North America and Asia.

Subcontinental regions (n=8) included were: Sub-Saharan Africa, Western Africa, Eastern Africa, Southern Africa, Northern Europe, Western Europe, Southern Europe and Central and Eastern Europe.

Other regions (n=4) included were: the European Union (EU-27), World, More-developed regions and Less-developed regions of the world. The Emerging HNC and UADTC rankings for these regions were evaluated for comparison.

2.3.2. Country-specific ranking
Ranking of HNC and UADTC was also examined at representative but randomly selected sub-Saharan and non-African country levels. This was done by comparing HNC and UADTC burden in the twelve selected countries.

African countries (n=6) included were: the Republic of South African Republic (South Africa), Mozambique, Zambia, Kenya, Nigeria and Sudan. Other countries (n=6) included were: the United States of America (USA), Japan, Germany, United Kingdom (UK), France (La Reunion) and France (Metropolitan).

HNC and UADTC burdens for these regions were compared with the data for all other cancers as had been effected for the regions. These burdens were also compared between African countries and the other six countries which had been included.

Finally, we compared the GLOBOCAN 2012 with the 2008 data using a similar methodology. Briefly, HNC and UADTC burdens were evaluated and compared for African regions and countries and other developed regions of the world. Also, the combined ASIRs of HNC and UADTC were compared with all other cancers.

3. RESULTS
The precise burden of cancers in the head and neck regions in Africa has been unclear due to several mitigating factors such as poor documentation of cases, poorly defined nomenclature and a lack of well-established functioning cancer registries across the continent.

Our findings using this uncomplicated approach to redistribute the combined Head and Neck cancer ASIR data have spurred our interest in uncovering the true burden of cancer in Africa and in enhancing possible understanding of the economic and health impact on the populations.

Currently, there is a dearth of locally derived data on head and neck cancer in many African nations; and it is plausible that accurate determination of the burden of a disease can be extrapolated from global data repositories as has been done here. All Age-Standardized Incidence Rates (ASIR) values are “per 100,000 persons per year”.

3.1. Global HNC and UADTC distribution
The combined indices of head and neck cancers, HNC and UADTC, were compared worldwide to determine the burden of disease in Africa compared with the rest of the world. For HNC, estimated ASIR were combined for the nasopharynx, other pharynx, lip, oral cavity and larynx.

Similarly, ASIR for these regions including esophagus were combined for UADTC. ASIR distribution for HNC revealed that less than 25% percent of the Africa continent,
mainly in the central and western parts of northern Africa have ASIR of less than 6.2, while other regions recorded greater values (Figure 2A, p481).

Hot spots for HNC as observed in this estimation were identified in the southern African region where ASIR values were mostly greater than 13.1, whilst the values were greater than 20.0 in the north-western parts of this region and in Madagascar. Values greater than 13.1 but less than 20.0 were found as well in some parts of eastern Africa.

In comparison with the rest of the world, hot spots for HNC were identified in northern and eastern Europe and most of the northern, central and southern parts of Asia. No region in northern America has HNC ASIR values greater than 20.0 except in the Caribbean region; and more than 50% of the northern America region has an HNC ASIR value below 13.1.

This picture changes dramatically when we look at the ASIR's of the UADTC; almost 25% of Africa is greater than 20.0. Nearly half of Africa is a UADTC hot spot if we lower the ASIR cut-off values to 14.2 and above.

There are areas with ASIR greater than 28.0 and less than 61.4 in eastern, southern and south-eastern Africa, as well as Madagascar (Figure 2B, p481). The UADTC burden did not seem to change much in northern America, while there was a shift in high burden of UADTC towards the southern regions of Asia.

### 3.2. Regional and Country derived data

We have chosen a few countries to demonstrate the difference in burden between highly developed nations compared with the less developed world. Twelve countries and sixteen regions were sampled in this study.

#### 3.2.1. Combined ASIR Ranking

The proportion of combined incidence of HNC and UADTC compared with that of other cancers was evaluated and ranked at the regional and country level. With a combined ASIR of 7.1, HNC ranked sixth in the world, in keeping with the literature. However, UADTC ranked 3rd globally with a combined ASIR of 12.0.

The ranking ranged between the fourth and fifth positions for most European regions and for northern America. HNC ranked fifth in Asia with a combined ASIR of 8.0 and notably was second in the UADTC ranking (Table 1, p486). The picture was quite different when we considered African regions which generally had rankings of higher incidence both for HNC and UADTC. HNC ranked third in Africa with a combined ASIR of 7.8, while UADTC ranked first with a combined ASIR of 13.2.

Looking at the sub-Saharan region HNC ranked fourth while UADTC ranked second. HNC ranked fourth and third in southern and western Africa respectively; while UADTC ranked second and third in these regions respectively.

Interestingly, UADTC ranked first in eastern Africa with a combined ASIR of 17.9 with a HNC ranking of fourth position and combined ASIR of 7.5.

These increasing trends of ranking in Africa were also demonstrated by stacked bar graphs and pie charts. (Figure 3A, p482 and Figure 4, p483).

#### 3.2.2. Comparisons according to Human Development Index

Another indicator that we examined was to compare the GLOBOCAN data on more developed regions of the world with that of less developed regions. Usefully, the database has readymade estimates on these two regions. Not surprisingly, when computing the HNC and UADTC ASIRs we found high rankings in less developed regions compared with the more developed region, a finding consistent with our findings so far.

HNC ranked fourth in the the less developed world with a combined ASIR of 8.4; while UADTC ranked second in anw relation to other cancer with a combined ASIR of 15.6. In contrast, HNC ranked sixth in the more developed world with a combined ASIR of 3.6 and UADTC, with a combined ASIR of 5.1, ranking fourth (Table 1, P486). Similar comparisons of ranking between these two regions can also be seen in the stacked bar graphs and pie charts (Figures 3A, P482 and Figure 5, p484).

#### 3.2.3. Consistent trends in 2012 update to the GLOBOCAN 2008 Database

While we had observed these pertinent findings using the GLOBOCAN 2008 database, we then evaluated the latest database for any major differences in HNC and UADTC and found that not much has changed in terms of these combined burdens.

Notably, UADTC now ranks second in Africa with a combined ASIR of 11.7; but still ranks fifth in North America with a combined ASIR of 6.2. HNC retains its third position ranking in Africa with a combined ASIR of 7.3 but drops to sixth position in North America with a combined ASIR of 4.6 (Figure 6, p484).
Figure 2. Map of global distribution of combined ASIR of oral cancer.
(A) Shows the Age standardized incidence rate (ASIR) of HNC is high in many regions of Africa as compared with the rest of the world. (B) Shows an increased burden of oral cancer when esophageal cancers are added to form the UADTC subset. Nearly half of the continent had hot spots with ASIR values of greater than 14.1. This demonstrates that the burden of oral cancer may be higher than currently reported in many literatures. There are areas of very high ASIRs in the southern and eastern regions of Africa as shown here.
Figure 3. Stacked bar charts of the distribution of HNC and UADTC. (A) Shows the high ranking distribution of HNC and UADTC by regional distribution and (B) shows similar trends by country-derived data. In each bar the relative proportion of HNC (blue) and UADTC (blue and burgundy) are shown in comparison with other cancers (green).
Figure 4. Pie chart showing regional distribution of HNC and UADTC in: the world, Africa, sub-Saharan (SSA) region and Southern Africa (SA). HNC (Dark blue) and UADTC (Dark blue and Burgundy) are located on the upper right quadrant of the pies. UADTC is responsible for a high fraction of cancers in Southern Africa and the burden of HNC and UADT is high in Africa as well as in the world.
Figure 5. Pie chart of comparison of HNC and UADTC between more- and less-developed regions of the world. HNC (Dark blue) and UADTC (Dark blue and Burgundy) are located on the upper right quadrant of the pies. There is higher ranking of HNC and UADTC in the less developed regions compared with the more developed regions. There is an almost equal distribution of HNC and Esophageal lesion in the less developed world; while there is a lower incidence of esophageal cancer in the more developed world compared with HNC.

Figure 6. Pie charts showing some recent updates to the GLOBOCAN database in 2012. HNC (Dark blue) and UADTC (Dark blue and Burgundy) are located on the upper right quadrant of the pies. HNC and UADTC still rank very high in Africa compared with North America in this new database.
4. DISCUSSION

There is an increasing burden of cancer in developing economies worldwide and researchers in these regions may be expected to play an important part in understanding its precise impact in the regions.

With limited healthcare facilities in developing countries, there is a current struggle to attend to the burdens of various infectious diseases. They are also ill-prepared for the pandemic levels that cancer may reach if counter measures are not promptly implemented.

Several factors interplay with the diagnosis and management of cancer in Africa, including cultural beliefs, religion, educational levels, lack of reliable public transport over great distances and poverty.

Religious beliefs, for example, have been found to play an important role in the attitude towards and management of cancer, and may play a role in a heavy cancer burden.

Political issues and governmental policies also contribute to the current situation in Africa. It has been reported that many of the poorest countries in the world allocate a substantial proportion of their health budget towards funding tertiary health facilities, as well as funding overseas health treatment trips for highly politically connected and privileged individuals, thereby denying the indigent populations access to good basic healthcare.

Focusing on addressing the severe inequalities that exist in cancer management in LMICs will improve control in a manner analogous to HIV treatment in Africa, which many imagined was a futile effort at its outset.

Many African countries are in the process of developing infrastructures for cancer control and management, while it appears there is minimal political will-power to support national cancer control programmes in some of the more developed economies in Africa.

Even though the World Health Organization has developed a comprehensive cancer control programme in developing countries, it would involve a joint global effort and methodologies to facilitate its practical application.

Importantly, beside governmental and non-governmental efforts in cancer control, an influential source of support is philanthropic, selfless support from the public must not be underestimated. Additionally, LMICs must develop a paradigm that does not promote exclusive media hegemony in the public understanding of the cancer control agenda.

Oral cancers, as has been demonstrated, account for a significant proportion of cancers in Africa. Hence oral cancer researchers in Africa are expected to play an important role in educating the public about the increasing burden of oral cancer and possible preventive measures required to reduce such burdens.

A review of the economic burden of head and neck cancer using 77 studies, mostly from the USA, revealed a generally high cost of management. For example, USA spent as much as US$8.5 billion in 2008 on cancer management; although African countries were not included in this study, such high spending would be prohibitive in Africa.

Many developing countries continue to spend small proportions of their annual gross domestic product (GDP) on healthcare. For instance, India (with a very high burden of oral cancer) in 2010 spent 3.7% of its GDP on health leading to contribution of up to 71.8% of expenditure on health from private pockets.

In contrast to this, in the United Kingdom in the same year, private contributions to healthcare expenditure totalled only 16.8%. Socioeconomic considerations, illiteracy and possibly chronic infection have been identified as important related factors for oral cancer in studies from Nigeria.

Another study reviewed 27 papers which had been published in Nigeria, finding a high burden of head and neck cancer in the country, but there is still a need for studies that compare the ranking of HNC and UADTC with other cancers in Nigeria.

Some studies described the burden of oral cancer in Kenya as very low, while others noticed an unchanged frequency or pattern of distribution in this population despite major lifestyle changes and the emergence of the HIV/AIDS epidemic. The same group later reported a prominence of head and neck cancer in the population.

The initial lower incidences previously reported in Kenya as compared with our study may be due to those researchers isolating only lip and oral cancer from the HNC or UADTC.

The burden of oesophageal cancers in Kenya is high, mainly accounted for by oral habits such as consumption of Chang’a, mursik and busaa; tobacco snuffing, and hot tea drinks, environmental nitrosamine exposure, and poor oral health and probably contributed to the high ranking of UADTC in Kenya, as revealed by our study.

A review of 33 oral cancer based publications from Sudan demonstrated that oral habits such as Toombak use and high risk HPV infection may play important roles in oral cancer aetiology.

A report from the Sudanese national population-based cancer registry in Khartoum revealed that oral cancer is the sixth highest ranked cancer in all adults older than 15 years and is commoner in males than in females in this population.

In contrast, the present study found HNC to be ranked second and UADTC ranked first, a disparity which may be due to the combined ASIR approach applied in the study.

Also to be borne in mind is the fact that there are many data discrepancies in the population and hospital based cancer registry records, particularly in the developing world. Even though there seems to be a higher ranking of HNC and UADTC in less developed areas compared with the more developed, a study from Egypt demonstrated that...
### Table 1. Table showing combined ASIR ranking of HNC and UADTC in sixteen selected regions.

<table>
<thead>
<tr>
<th>Region</th>
<th>Combined ASIR</th>
<th>Combined ASIR</th>
<th>Ranking</th>
<th>Combined ASIR</th>
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<td>4.9</td>
<td>6th</td>
<td>12.0</td>
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<td>Europe</td>
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<td>13.2</td>
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<tr>
<td>Sub-Saharan Africa</td>
<td>7.4</td>
<td>6.6</td>
<td>2nd</td>
<td>14.0</td>
</tr>
<tr>
<td>Southern Africa</td>
<td>8.1</td>
<td>10.0</td>
<td>2nd</td>
<td>18.1</td>
</tr>
<tr>
<td>Western Africa</td>
<td>7.3</td>
<td>1.5</td>
<td>3rd</td>
<td>8.8</td>
</tr>
<tr>
<td>Eastern Africa</td>
<td>7.5</td>
<td>10.4</td>
<td>1st</td>
<td>17.9</td>
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<tr>
<td>Less Developed Regions</td>
<td>8.4</td>
<td>7.2</td>
<td>2nd</td>
<td>15.6</td>
</tr>
<tr>
<td>More Developed Regions</td>
<td>3.6</td>
<td>1.5</td>
<td>4th</td>
<td>5.1</td>
</tr>
<tr>
<td>North America</td>
<td>4.7</td>
<td>1.7</td>
<td>5th</td>
<td>6.4</td>
</tr>
<tr>
<td>Asia</td>
<td>8.0</td>
<td>7.6</td>
<td>2nd</td>
<td>15.6</td>
</tr>
</tbody>
</table>

**HNC:** includes oral cavity and lip, nasopharynx, other pharynx and larynx excluding the esophagus; **UADTC:** includes HN + Esophagus.

### Table 2. Table showing relative incidence ranking of HNC and UADTC in twelve selected countries.

<table>
<thead>
<tr>
<th>Countries</th>
<th>Combined ASIR</th>
<th>Combined ASIR</th>
<th>Ranking</th>
<th>Combined ASIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>South African Republic (RSA)</td>
<td>8.0</td>
<td>10.0</td>
<td>4th</td>
<td>18.0</td>
</tr>
<tr>
<td>United States Of America (USA)</td>
<td>4.7</td>
<td>1.7</td>
<td>5th</td>
<td>6.4</td>
</tr>
<tr>
<td>Germany</td>
<td>4.6</td>
<td>1.9</td>
<td>5th</td>
<td>6.5</td>
</tr>
<tr>
<td>France (La Reunion)</td>
<td>13.9</td>
<td>8.6</td>
<td>1st</td>
<td>22.5</td>
</tr>
<tr>
<td>France (Metropolitan)</td>
<td>5.9</td>
<td>1.8</td>
<td>4th</td>
<td>7.7</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>4.0</td>
<td>3.5</td>
<td>4th</td>
<td>7.5</td>
</tr>
<tr>
<td>Nigeria</td>
<td>8.9</td>
<td>1.4</td>
<td>3rd</td>
<td>10.3</td>
</tr>
<tr>
<td>Zambia</td>
<td>5.5</td>
<td>6.4</td>
<td>3rd</td>
<td>10.3</td>
</tr>
<tr>
<td>Kenya</td>
<td>7.7</td>
<td>11.2</td>
<td>1st</td>
<td>18.9</td>
</tr>
<tr>
<td>Mozambique</td>
<td>6.1</td>
<td>13.4</td>
<td>3rd</td>
<td>19.5</td>
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<tr>
<td>Sudan</td>
<td>10.5</td>
<td>5.7</td>
<td>1st</td>
<td>16.2</td>
</tr>
<tr>
<td>Japan</td>
<td>3.1</td>
<td>4.1</td>
<td>5th</td>
<td>7.2</td>
</tr>
</tbody>
</table>

**HNC:** includes oral cavity and lip, nasopharynx, other pharynx and larynx excluding the esophagus; **UADTC:** includes HN + Esophagus.
the overall incidence of HNC was higher in the urban areas as compared with the rural areas. An increasing trend in the incidence of HNC in South Africa has been reported over the years from 1992 to 2001, and it was observed that Mixed Ancestry ("Coloured") South Africans had the highest incidences among all ethnicities.

It was also observed that Blacks had the least incidences, but this is almost certainly due to poor access to healthcare, especially in the rural areas, leading to missing data.

Such intra-country disparity in HNC and UADTC distribution is yet to be investigated in many African countries and warrants further research.

5. CONCLUSION AND RECOMMENDATION

The combined burden of cancers in the head and neck region requires substantial further research attention in Africa. Understanding the molecular biology and potential novel targeted therapies which may be applicable for oral cancer in Africans will bring appreciable progress to reducing the burden of HNC and UADTC in Africa.

Considering that the diagnostic and treatment opportunities for HNC and UADTC in sub-Saharan Africa are generally dismal, there is a great need to prioritise the financing of UADTC research efforts in Africa by NGO's, governmental agencies, philanthropists and health policy makers.

Establishment of mutually beneficial collaborations, linkages, training and infrastructure development should be urgently promoted in Africa through establishing sustainable Research and Education Networks (RENs) within Africa, in collaboration with the more developed world.

As the journey of understanding the true burden of HNC and UADTC in Africa unfolds; clinicians, pathologists, basic medical scientists, molecular cancer biologists and statisticians need to apply their concerted efforts to reducing the burden of cancer in the continent – and globally.

Conflicts of interests

The Authors declare that they have no conflict of financial or non-financial interest.

Authors’ contributions

HAA was involved in the conceptualization/design (45%), manuscript drafting (60%), data analysis (50%) and revision (40%); AHA was involved in the design (10%), manuscript drafting (10%) data analysis (10%) and revision (20%); JJH was involved in the conceptualization/design (45%), manuscript drafting (30%), data analysis (40%) and revision of this work.

All authors were involved in preparing the manuscript and had final approval of the submitted and published versions.

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References

The relationship between oral candidiasis and micronutrient deficiency amongst adult tuberculosis patients in Alexandra, Johannesburg

ABSTRACT

Introduction
Tuberculosis (TB), a major public health problem worldwide, is associated with micronutrient deficiency and wasting, and co-infections could worsen the condition.

Aim
To investigate the relationship between micronutrient deficiency and oral candidiasis in adult TB patients.

Methods
A cross-sectional study among 88 TB adult patients in Alexandra, Johannesburg. Patients underwent a complete oral examination to establish the prevalence of candidiasis and blood was collected for the assessment of micronutrient levels.

Results
The mean age of participants was 36.66 years of age, the majority being female (60.23%) and HIV positive (69.30%). The prevalence of oral candidiasis was 39.77% with pseudomembranous being most common (48.00%). In those with micronutrient deficiencies, oral candidiasis was prevalent in 40% patients with Zinc deficiency, 25.00% with Vitamin A deficiency, 32.00% with Albumin deficiency, 33.00% with Selenium deficiency, 31.00% with Iron deficiency and in 36.00% with Vitamin D deficiency.

Conclusion
There was a significant association between the presence of oral candidiasis in TB/HIV co-infected patients and Zinc, Vitamin A and Vitamin D deficiencies, but not in the TB only group.

Keywords
Tuberculosis, Human Immunodeficiency Virus, Oral Candidiasis, Zinc, Iron, Albumin, Selenium, Vitamin A and Vitamin D micronutrient deficiency

INTRODUCTION

Mycobacterium tuberculosis (M. tuberculosis) is the most widespread bacterial pathogen in the world, infecting approximately two million people globally on an annual basis.1

Tuberculosis (TB) is a major public health problem in South Africa, with an estimated 450,000 cases of active TB in 2013.2 The control of TB is complicated by the Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS), with 60.00% of TB patients in South Africa also having HIV.3

In South Africa, TB is associated with poverty, overcrowding, alcoholism, stress, drug addiction and malnutrition.4 An important component of malnutrition is “micronutrient deficiency”, which refers to the lack of sufficient micronutrients in an individual.

Micronutrient deficiency leads to low energy levels, low immunity, higher rates of disability and chronic illness among affected populations.5
Those most at risk are children, pregnant and breastfeeding mothers, people living with HIV/AIDS (PLWA) and/or TB. A 2013 report estimated there were 6.1 million people living with HIV in South Africa, with 240,000 South Africans dying annually from AIDS-related illnesses.

These people are particularly vulnerable to extensively drug-resistant tuberculosis because of their increased susceptibility to infection through nosocomial transmission, malabsorption of TB medication, acquired rifampicin resistance and poor response to TB therapy. Patients who have HIV/AIDS, TB and pneumonia are susceptible to opportunistic infections, such as oral candidiasis.

The most common oral candidiasis lesions are pseudo-membranous candidiasis, erythematous candidiasis (oral candidiasis) and angular cheilitis. Micronutrient deficiencies have been reported in individuals with TB and in those with HIV infection alone.

Nutritional deficiencies of Vitamin B12, Zinc and Selenium in malnourished PLWA are associated with decreased immune indices and a higher risk for disease progression.

Oral manifestations of nutritional deficiency include non-specific signs and symptoms that involve the mucous membranes, the teeth, the periodontal tissues, the salivary glands and the perioral skin.

Oral candidiasis is one of the oral lesions strongly associated with manifestations of HIV/AIDS; it is regarded as a marker for immune suppression and for the onset of HIV/AIDS. Oral candidiasis has been reported in 50.00% to 95.00% of all HIV-positive persons at some point during their progression to AIDS.

Opportunistic infections and co-infections that are common among HIV-infected individuals are TB, chronic diarrhoea, oral candidiasis, herpes simplex virus-2 (HSV-2), cytomegalovirus (CMV), hepatitis B virus (HBV) and hepatitis C virus (HCV).

The most common dual infections are chronic diarrhoea (CD) and oral candidiasis, oral candidiasis and TB, CD with TB, HSV-2 and oral candidiasis, HSV-2 and CMV, HBV and HSV-2, HBV and CMV. The least common dual infections are HCV and HBV.

The most common triple infections are oral candidiasis, TB and CD and HSV-2, CMV and CD. Micronutrient deficiencies of Iron, Folic acid, Vit A, B, C, K and Zinc, and a carbohydrate-rich diet have a significant impact on the pathogenesis of oral candidiasis infection.

Paillaud et al. found that oral candidiasis is related to malnutrition and Gupta et al. reported an association between TB and micronutrient deficiency in adults. However, few studies exist that have investigated the association between oral candidiasis and malnutrition in adults with TB.

A comprehensive understanding of the existence of an association between oral candidiasis and malnutrition is important for prevention and for treatment interventions in TB patients.

This study sought to determine the relationship between oral candidiasis and micronutrient deficiency in adults with TB and TB/HIV co-infection, living in Alexandra, Johannesburg.

The objectives were: to determine the prevalence of oral candidiasis amongst TB patients and among TB/HIV co-infected patients; to investigate the association between oral candidiasis and micronutrient status among TB patients and TB/HIV co-infected patients.

MATERIALS AND METHODS

Alexandra, in north eastern Johannesburg, South Africa, has a population of over half a million people living in an area of approximately two square kilometers, with high HIV/AIDS, TB and unemployment rates.

A cross-sectional, analytical study design was adopted for the study, which was part of a large longitudinal study that investigated the impact of a fortified supplementary food on the health and well-being of TB patients. The sample size, therefore, was determined by that larger study.

The inclusion criteria were male and female outpatients, between the ages of 18–60, receiving TB treatment from a clinic in Alexandra. The inclusion criteria also covered a history of at least three regular clinic visits and consent to participate in the study.

The exclusion criteria were: inpatients, outpatients with fewer than three clinical visits, and those receiving treatment for multi-drug resistant TB.

The South African National Tuberculosis Association (SANTA) assisted in identifying Johannesburg clinics in Alexandra that provided TB outpatients with treatment and support. Four Johannesburg clinics were identified and the two with the highest number of TB patients were selected as research sites.

The total sample screened and recruited comprised 120 patients. In only 88 participants was an oral examination carried out and blood specimens collected, as 32 of the recruited participants were not present on the day of examination and blood sample collection.

A questionnaire was designed to establish the demographics and HIV status of the sample population. The oral examination was conducted at the research site by a dentist and a dental therapist, both calibrated.

The patients were seated on mobile dental chairs and examined under headlamp, with disposable hand mirrors being used according to the WHO basic methods recommendations. The inter-examiner agreement was assessed using the kappa statistic, with an overall value of 0.80 – 0.95 for the diagnosis of oral candidiasis.

The diagnosis of the clinical variants of oral candidiasis was made in accordance with the criteria developed by Sharon and Fazel. These criteria characterize pseudo-membranous candidiasis by the presence of extensive white pseudo-membranes consisting of desquamated epithelial cells, fibrin and fungal hyphae.
Erythematous candidiasis is characterized by bright red patches that can be found intraorally; and angular cheilitis is characterized by erythematous fissuring at one or both corners of the mouth and an association with an intraoral candidial infection. Blood samples were collected for serum analysis of the levels of the micronutrients: Selenium, Albumin, Vitamin A, Vitamin D, Iron and Zinc. These data were compared with Alan’s normal micronutrient levels.23

The relationship between each individual deficient micronutrient and the prevalence of oral candidiasis was analysed to determine if there was a significant association (p < 0.05). Within this group of TB patients were patients who were also infected with HIV.

The micronutrient levels were analysed in this TB/HIV sub-group and the data compared with the TB only group. STATA 11 software was used for all statistical analysis. To describe micronutrient levels, the means (standard deviations) and medians (inter-quartile ranges) were used.

Frequencies (percentages) were used to describe categorical variables such as sex, HIV status and employment status. Where comparisons were made, Pearson’s Chi-squared test (or Fisher’s exact test), the Student t-test or Wilcoxon rank-sum test were used as appropriate. Logistic regression was used to identify factors that were independently associated with a diagnosis of oral candidiasis.

The odds ratios were used to determine the strength of the association. The statistical significance was calculated at the 5% significance level and estimates were reported at the 95% confidence interval.

The Human Ethics Research Committee at the University of the Witwatersrand (M10733), Johannesburg, granted ethics approval. Permission to conduct the study was given by the SANTA and informed written consent was obtained from all participants who volunteered to participate in the study.

RESULTS

The mean age of the total sample (n=88) was 36.66 years (SD. 9.97) with the majority of patients being HIV positive (69.30%). The mean values of the levels of most of the micronutrients (Zinc, Vitamin A, Selenium, Iron, and Albumin) were above the normal ranges.

The exception was Vitamin D, which had a mean level below the normal range (47.96 nmol/L; S.D. 17.91) and 54.90% of the sample recorded a Vitamin D deficiency (Table 1, p491). The mean blood serum level of the micronutrients investigated in the TB/HIV co-infected cases was 69.32% (n=61). The mean values of the levels of all the micronutrients (Zinc, Vitamin A, Selenium, Iron, Albumin and Vitamin D) were above the normal ranges of these micronutrients (Table 2, p491).

In the study sample 39.77% of patients (n=35) had oral candidiasis and 60.22% (n=53) did not have oral candidiasis present. In terms of prevalence of oral candidiasis by clinical type, 48.00% (n=17) of the TB patients had pseudomembranous candidiasis, 28.00% (n=10) had erythematous candidiasis, 14.00% (n=5) had angular cheilitis and 10.00% (n=3) presented a hyperplastic appearance. The prevalence of oral candidiasis was higher among the females (47.17%) than among males (28.57%) and the unemployed subjects had a slightly higher prevalence of oral candidiasis (41.53%) than did those employed (34.78%).

Forty one per cent of TB/HIV co-infected patients presented with oral candidiasis compared with 7.03% of TB patients (p=0.754). There was no statistically significant relationship between oral candidiasis and any of the demographics (Table 3, p493). For subjects with oral candidiasis, micronutrient levels below the normal range were present among 40% of patients for Zinc, 26% for Vitamin A, 33% for Selenium, 32% for Iron, 32% for Albumin and 33% of the sample for Vitamin D.

For TB patients with oral candidiasis, micronutrient levels within the normal range were present among 23.00 % for Zinc, 47.00% for Vitamin A, 24.00% for Selenium, 39.00% for Iron, 30.00% for Albumin and 17.00% for Vitamin D.

Oral candidiasis was not significantly associated with lower levels of micronutrients when compared with normal micronutrient levels in TB patients who had no oral candidiasis (Table 4, p493).

No significant association existed between the demographic variables or the micronutrient levels and the presence of oral candidiasis in TB patients (Table 5, p495). Sex [OR:0.61(95% CI:0.24-1.52)], Employment status [OR:1.13 (95% CI: 0.42-3.09)], HIV status [OR: 1.12[95% CI : 0.44-3.44]], Micronutrient level of Zinc [OR:2.25 (95% CI: 0.61-8.25)], Vitamin A [OR:0.37 (95% CI: 0.13-1.07)] , Selenium [OR: 11.41 (95% CI 0.12-17.11) , Iron [OR: 0.75 (95% CI: 0.27-2.03) , Albumin [OR:10.82 (95% CI: 0.28-2.41)] and Vitamin D [OR: 2.25 (95% CI: 0.61-8.25)].

However, in patients with TB/HIV co-infection there was a significant association between the presence of oral candidiasis and deficiencies in the levels of Zinc [OR: 2.25 (95% CI: 1.9-2.4)], Vitamin A [OR: 1.5 (95% CI: 1.2-1.8)] and Vitamin D [OR: 2.83 (95% CI: 2.45-3.00)] (Table 6, p495).

DISCUSSION

This study sought to investigate the relationship between oral candidiasis and micronutrient deficiencies in adults with TB and with TB/HIV co-infection. The majority of the study participants were females (60.23%) and unemployed (73, 90%).

The higher percentage of females might simply be because more females have TB or are co-infected with TB and HIV but may be more likely to be compliant in attending clinics for TB treatment and recall visits than males.24 Also, Brennan et al.26 reported that females tend to make use of public health services more often than males.

Although 69.32% of the TB patients in the current study were HIV positive, John et al.27 reported a 90% rate of TB/HIV co-infection amongst patients admitted to the Medical Ward in Helen Joseph Hospital in Johannesburg. This level of co-infection is significantly higher than the prevalence
Table 1: Individual micronutrient deficiency of TB patients (n=88)

<table>
<thead>
<tr>
<th>Micronutrients</th>
<th>n</th>
<th>%</th>
<th>Median(IQR)</th>
<th>Mean (Std Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc n = 49</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 8.2 µmol/L)</td>
<td>34</td>
<td>69.39</td>
<td>10.05 (7.40 – 11.10)</td>
<td>10.60 (4.66)</td>
</tr>
<tr>
<td>Yes (&lt; 8.2 µmol/L)</td>
<td>15</td>
<td>30.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vit A n = 65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 1.05 µmol/L)</td>
<td>34</td>
<td>52.31</td>
<td>1.05 (0.74 – 1.46)</td>
<td>1.13 (0.43)</td>
</tr>
<tr>
<td>Yes (&lt; 1.05 µmol/L)</td>
<td>31</td>
<td>47.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selenium n = 44</td>
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</tr>
<tr>
<td>No (&gt; 46 µg/L)</td>
<td>41</td>
<td>93.18</td>
<td>68.00 (58.00 – 83.00)</td>
<td>69.12 (17.41)</td>
</tr>
<tr>
<td>Yes (&lt; 46 µg/L)</td>
<td>3</td>
<td>6.82</td>
<td></td>
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</tr>
<tr>
<td>Iron n = 67</td>
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<td></td>
</tr>
<tr>
<td>No (&gt; 9 µmol/L)</td>
<td>36</td>
<td>53.73</td>
<td>10.10 (6.60 – 15.80)</td>
<td>11.19 (6.59)</td>
</tr>
<tr>
<td>Yes (&lt; 9 µmol/L)</td>
<td>31</td>
<td>46.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albumin n= 67</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 35 g/L)</td>
<td>46</td>
<td>68.66</td>
<td>38.00 (33.00 – 41.00)</td>
<td>37.28 (5.55)</td>
</tr>
<tr>
<td>Yes (&lt; 35 g/L)</td>
<td>21</td>
<td>31.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vit D n= 51</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 49 nmol/L)</td>
<td>23</td>
<td>45.10</td>
<td>46.35 (36.13 – 60.23)</td>
<td>47.96 (17.91)</td>
</tr>
<tr>
<td>Yes (&lt; 49 nmol/L)</td>
<td>28</td>
<td>54.90</td>
<td></td>
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</tbody>
</table>

Table 2: Individual micronutrient deficiency of TB/HIV co-infected patients (n=61)

<table>
<thead>
<tr>
<th>Micronutrients</th>
<th>N</th>
<th>%</th>
<th>Median(IQR)</th>
<th>Mean (Std Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc n = 35</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 8.2 µmol/L)</td>
<td>15</td>
<td>43.00</td>
<td>10.00 (6.20– 11.00)</td>
<td>9.60 (5.82)</td>
</tr>
<tr>
<td>Yes (&lt; 8.2 µmol/L)</td>
<td>20</td>
<td>57.00</td>
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<td></td>
</tr>
<tr>
<td>Vit A n = 28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 1.05 µmol/L)</td>
<td>17</td>
<td>60.71</td>
<td>1.00 (0.82 – 1.32)</td>
<td>1.08 (0.68)</td>
</tr>
<tr>
<td>Yes (&lt; 1.05 µmol/L)</td>
<td>11</td>
<td>39.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selenium n = 36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 46 µg/L)</td>
<td>23</td>
<td>64.00</td>
<td>62.00 (55.00-73.00)</td>
<td>67.15 (13.28)</td>
</tr>
<tr>
<td>Yes (&lt; 46 µg/L)</td>
<td>13</td>
<td>36.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron n = 36</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>No (&gt; 9 µmol/L)</td>
<td>15</td>
<td>41.66</td>
<td>9.63 (7.80 – 13.80)</td>
<td>10.60 (7.20)</td>
</tr>
<tr>
<td>Yes (&lt; 9 µmol/L)</td>
<td>21</td>
<td>58.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albumin n= 37</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 35 g/L)</td>
<td>23</td>
<td>62.00</td>
<td>39.00 (31.00-39.00)</td>
<td>38.42 (4.62)</td>
</tr>
<tr>
<td>Yes (&lt; 35 g/L)</td>
<td>14</td>
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<tr>
<td>Vit D n= 46</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 49 nmol/L)</td>
<td>17</td>
<td>37.00</td>
<td>44.28 (34.22 – 61.48)</td>
<td>49.46 (19.84)</td>
</tr>
<tr>
<td>L. (&lt; 49 nmol/L)</td>
<td>29</td>
<td>63.00</td>
<td></td>
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</tr>
</tbody>
</table>
In TB cases, nutrients (e.g. Iron, Copper, Selenium and Zinc) are compartmentalised to the tissues, lost from the body and/or blocked from cellular utilization. Approximately forty per cent (n=35) of the TB patients in this study had oral candidiasis, with pseudomembranous oral candidiasis being overall the most prevalent (48.00%), more prevalent in females and in those above the mean age of 37, but the differences were not significant.

Ikebe et al. also reported that candidal activity was not significantly associated with age or sex in relatively healthy individuals of above 60 years of age, as certain systemic conditions (e.g. diabetes mellitus), defects of the immune system 34-36, and some medications (e.g. antibiotics, corticosteroids) may predispose towards the transformation of colonisation of species such as Candida into opportunistic pathogens.

In addition, oral candidiasis was more prevalent in HIV-positive (40.98%) patients than in HIV-negative patients, although the difference was not significant. This finding is in line with the findings of Akpan et al., who reported that 95.00% of HIV-positive individuals in their study had oral candidiasis. In the majority of HIV-positive patients, oral candidiasis is often present as an initial manifestation of HIV infection, and is a useful clinical marker of patients with high viral load.

Even though only 40.98% of the HIV-positive cases in the current study had oral candidiasis, evidence has shown that oral candidiasis is one of the key opportunistic infections that occur commonly and that it frequently presents in HIV-positive cases. The oral cavity is a reservoir of different potential pathogens – bacterial, viral and fungal – which can multiply and cause disease in malnourished and immunocompromised patients.

Samaranayake et al. reviewed the literature and contend that only a few studies have investigated nutrient factors such as Zinc, Albumin, Selenium, Iron, Vitamins A and D and their possible role in the alteration of oral mucosal integrity.

In this study, 30.61% of the sample had Zinc deficiency; this prevalence was significantly lower than that reported by Koyanagi et al. in their study of 56 TB patients, 61.00% of whom had Zinc deficiency. A study investigating the relationship between wasting and micronutrient malnutrition conducted by van Lettow et al. also reported that TB patients (n=801) were at a higher risk of Zinc deficiency with a prevalence as high as 85.00%.

Tuberculosis/HIV co-infection worsens Zinc deficiency in patients; in the current study 57.00% of the TB/HIV co-infected patients had Zinc deficiency. Studies have also shown Zinc deficiency to be more prevalent in TB/HIV co-infected cases versus TB only controls. In the present study, 40.00% of the TB patients had oral candidiasis and Zinc deficiency and 23.00% had oral candidiasis associated with Zinc levels in the normal range. However, there was no significant relationship between oral candidiasis and Zinc deficiency. In contrast, Paillaud et al. reported a significant association between oral candidiasis and Zinc deficiency (44.00%; p=0.031).

An estimated 69.32% of the current sample were co-infected with TB/HIV and Baum et al. reported Zinc deficiency in 56.00% of HIV-positive drug users (n=118). It is important to note that Zinc deficiency has been linked to a declining CD4 count in HIV-positive individuals because in that status the generation of T cells is reduced and humoral and cell-mediated immunity are depressed; thus, Zinc supplements are important in Zinc-deficient HIV/AIDS patients even among those being administered HAART.

Unfortunately, in our study this analysis was not possible because of the number of CD4 count records that were unavailable. There was Iron deficiency in 46.27% of our TB patients, of whom 58.00% were from the TB/HIV co-infected patients, with no significant association between Iron deficiency and TB or TB/HIV co-infection.

This finding is in contrast to the findings reported by Kassu et al. who found that there was a significant difference in Iron deficiency between TB/HIV co-infected patients (n=74) and healthy controls (n=31) (p<0.05). There was also Iron deficiency in the TB patients without HIV co-infection versus healthy controls, but the difference was not statistically significant (p<0.07). Taha and Thanoon also reported that serum Iron values were significantly lower in pulmonary TB cases (n=40) in comparison with controls (n=50; p<0.001).

Although the current study did not find a significant association between Iron deficiency and TB-only infected cases and TB/HIV co-infected cases, studies have shown that severe Iron deficiency in TB/HIV co-infected cases is directly linked to HIV infection, as HIV-positive cases experience reduction in food intake and malabsorption of nutrients, making patients co-infected with TB/HIV more vulnerable to Iron deficiency.

Oral candidiasis was present in patients both with Iron deficiency and those with Iron levels within the normal range. There was no significant difference between those with high Iron and oral candidiasis compared with those with low Iron levels. Neither could Walker et al. find any differences in the frequency of oral candidiasis or oral carriage rate of Candida in Iron-deficient subjects and controls, nor there a significant change in the disease process observed after Iron replacement therapy.

Similarly, Samaranayake identified five Iron-deficient patients with chronic atrophic oral candidiasis in whom adequate restoration of serum Iron levels had no effect on the recurrence of oral candidiasis. In addition, Jenkins et al. could not establish a relationship between Iron deficiency and chronic atrophic or hyperplasic variety of oral candidiasis. Recurrent oral candidiasis infection in normal Iron levels could be the result of diseases, such as diabetes mellitus and dentures. Paillaud et al. reported a high prevalence of oral candidiasis in hospitalised patients above 70 years of age who were Iron-deficient and also had angular cheilitis and atrophic glossitis. The difference
### Table 3: Associations between oral candidiasis and demographics (n=88)

<table>
<thead>
<tr>
<th>Demographics</th>
<th>No oral candidiasis (n=53)</th>
<th>Oral candidiasis Present (n=35)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age in years</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>35.50 (28.00 – 42.00)</td>
<td>38.00 (31.00 – 44.00)</td>
<td>0.702</td>
</tr>
<tr>
<td>Mean (Std Deviation)</td>
<td>36.50 (10.21)</td>
<td>37.35 (8.47)</td>
<td></td>
</tr>
<tr>
<td><strong>Demographic Variables</strong></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>28</td>
<td>52.83</td>
<td>25</td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>25</td>
<td>71.43</td>
<td>10</td>
</tr>
<tr>
<td><strong>Unemployed</strong></td>
<td>38</td>
<td>58.46</td>
<td>27</td>
</tr>
<tr>
<td><strong>Employed</strong></td>
<td>15</td>
<td>65.22</td>
<td>8</td>
</tr>
<tr>
<td><strong>HIV Negative (TB positive)</strong></td>
<td>38</td>
<td>58.46</td>
<td>27</td>
</tr>
<tr>
<td><strong>HIV Positive (TB/HIV co-Infection)</strong></td>
<td>36</td>
<td>59.01</td>
<td>25</td>
</tr>
</tbody>
</table>

*p value for Student’s t test for normally distributed continuous variables (e.g. Age), Wilcoxon rank-sum test for non-normal continuous variables and Pearson’s Chi squared test for categorical variables, Fisher’s exact test for categorical variables with n < 5 per cell.

### Table 4: Associations between oral candidiasis and micronutrient deficiency amongst TB/HIV co-infected patients (n=61)

<table>
<thead>
<tr>
<th>Micronutrient Deficiency</th>
<th>No Oral Candidiasis</th>
<th>Oral candidiasis Present</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Zinc n=49</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 8.2 µmol/L)</td>
<td>26</td>
<td>77.00</td>
<td>8</td>
</tr>
<tr>
<td>Yes (&lt; 8.2 µmol/L)</td>
<td>9</td>
<td>60.00</td>
<td>6</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>10.05 (8.20-11.10)</td>
<td>9.60 (8.80-12.90)</td>
<td>0.705</td>
</tr>
<tr>
<td><strong>Vitamin A n=65</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 1.05 µmol/L)</td>
<td>18</td>
<td>53.00</td>
<td>16</td>
</tr>
<tr>
<td>Yes(&lt; 1.05 µmol/L)</td>
<td>23</td>
<td>74.00</td>
<td>8</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>0.99 (0.69-1.32)</td>
<td>1.21 (0.99-1.58)</td>
<td>0.182</td>
</tr>
<tr>
<td><strong>Selenium n=44</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 46 µg/L)</td>
<td>31</td>
<td>76.00</td>
<td>10</td>
</tr>
<tr>
<td>Yes (&lt; 46 µg/L)</td>
<td>2</td>
<td>67.00</td>
<td>1</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>68.00 (58.00-83.00)</td>
<td>65.00 (58.50-78.50)</td>
<td>0.739</td>
</tr>
<tr>
<td><strong>Iron Deficiency n=67</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 9 µmol/L)</td>
<td>22</td>
<td>61.00</td>
<td>14</td>
</tr>
<tr>
<td>Yes (&lt; 9 µmol/L)</td>
<td>21</td>
<td>69.00</td>
<td>10</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>9.5 (6.90-15.20)</td>
<td>10.10 (6.05-17.00)</td>
<td>0.816</td>
</tr>
<tr>
<td><strong>Albumin n=67</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 35 g/L)</td>
<td>32</td>
<td>70.00</td>
<td>14</td>
</tr>
<tr>
<td>Yes (&lt; 35 g/L)</td>
<td>14</td>
<td>67.00</td>
<td>7</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>37.00 (34.00-41.00)</td>
<td>39 (31.50-40.50)</td>
<td>0.978</td>
</tr>
<tr>
<td><strong>Vitamin D</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 49 nmol/L)</td>
<td>19</td>
<td>83.00</td>
<td>4</td>
</tr>
<tr>
<td>Yes (&lt; 49 nmol/L)</td>
<td>18</td>
<td>64.00</td>
<td>10</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>48.83 (36.13-60.23)</td>
<td>43.39 (35.81-64.58)</td>
<td>0.739</td>
</tr>
</tbody>
</table>

*p value for Wilcoxon rank-sum test for non-normal continuous variables and Pearson’s Chi squared test for categorical variables, Fisher’s exact test for categorical variables with n < 5 per cell.
in the findings may be the result of the difference in the demographics of the population (age and hospitalised) and the study design.

Also institutionalisation may render elderly individuals vulnerable to nutritional deficiency because the storage of foods and the cooking procedures used in institutions may contribute to the loss of vitamins from the food.

Hospitalised elderly TB patients also have limited food choice, which ultimately affects their food intake and micronutrient serum levels as compared with TB outpatients. There is also a high prevalence of edentulousness in elderly patients, which limits their food choice and impacts negatively on their micronutrient status as compared with the TB dentate sample. The population had more than 20 teeth in their mouths.

Also none of the sample for the current study had dentures while the sample used in Sheilham’s study had dentures. Dentures and old age are a high risk for oral candidiasis, which probably explains findings of Paillaud et al.

In this study, 48.00% of the sample had Vitamin A deficiency; this result compares closely with Koyanagi et al., who showed that there was a significantly lower mean Vitamin A presence in the TB cases compared with the non-TB controls.

However, Karyadi et al. in a randomised controlled trial investigating whether Vitamin A and Zinc supplementation increased the efficacy of anti-tuberculosis treatment with respect to clinical response and nutritional status, reported that at baseline 32.00% of newly diagnosed TB patients (n=80) had Vitamin A deficiency.

The lower percentage of Vitamin A deficiency in Karyadi et al.’s study is probably because the sample consisted of newly diagnosed TB patients who had never received any anti-TB intervention. In our study, Vitamin A deficiency was seen in 60.71% of the TB/HIV co-infected patients as compared with 47.69% of the TB-only infected patients. The high proportion of individuals with low Vitamin A levels in the TB/HIV co-infected subgroup cannot be explained by nutritional deficiencies alone.

Studies have also shown that low Vitamin A levels are common in patients with TB and in those infected with HIV and are even more severe among patients with HIV/TB co-infection.

Mugusi et al. reported that serum Vitamin A levels were lower among HIV-infected individuals and lowest among TB/HIV co-infected patients. Low levels of Vitamin A were found to be more common among TB patients with a significantly higher prevalence among the HIV positive (64.40%) than in healthy controls (9.10%).

Although the current study did not show any significant association between Vitamin A deficiency and TB or TB/HIV co-infected subgroups, it seems that TB/HIV co-infection may potentially worsen Vitamin A deficiency more than TB or HIV alone because Vitamin A deficiency is associated with TB/HIV co-infection and more pronounced with HIV disease progression.

Approximately 7.00% of the TB patients in this study had Selenium deficiency. Koyanagi et al. reported a significantly lower Selenium concentration in pulmonary TB cases in Ecuador than in the healthy controls. Koyanagi et al. also reported that only 6.52% HIV/TB cases had Selenium deficiency; whereas our study found that of the 69.32% of the sample who had TB/HIV co-infected cases, 33.00% had Selenium deficiency.

An inverse correlation between Selenium and HIV infection was reported by Dworkin, as plasma Selenium in AIDS patients was found to be significantly lower in AIDS cases than in the healthy controls. Patients with AIDS had more severe Selenium deficiency compared with those with earlier stages of HIV infection. The current study and other reported studies indicate that those with TB/HIV co-infection are susceptible to lower concentrations of Selenium as compared with TB-only infected cases or healthy controls (non-TB).

Furthermore, Kassu et al. reported that the mean serum level of Selenium was significantly lower in pregnant women with HIV co-infection compared with HIV-negative pregnant women. Oral candidiasis was present in patients with Selenium deficiency (33.00%) and in patients with Selenium levels within the normal range (24.00%), with no significant difference between oral candidiasis levels and Selenium levels. Whilst the current study did not analyse the viral loads in the TB/HIV co-infected cases, Dworkin reported significantly lower Selenium levels in AIDS cases than in controls.

Selenium deficiency is common in HIV-positive- and AIDS patients. AIDS patients tend to have more severe deficits than those with earlier stages of HIV infection. Albumin deficiency was found in 31.34% of the TB cases, and in 38.00% of the TB/HIV co-infected cases, with no statistically significant association. However, Ramakrishnan et al. reported significantly lower serum levels of Albumin in TB/HIV co-infected cases than in TB cases.

Mugusi et al. also reported that the mean serum Albumin was significantly lower in HIV-positive patients; however, when Okamura et al. further investigated the relationship between hypoalbuminemia and computed tomography studies of the lungs, the finding was reported that hypoalbuminemia was significantly related to the presence of typical radiographic evidence of TB in patients of over 70 years of age. Fifty-five per cent of the TB patients in the current study had Vitamin D deficiency; however, a case control study by Ho-Pham et al. reported that the prevalence of Vitamin D insufficiency was 35.40% in men with TB and 19.50% in controls (p=0.01). In women, there were no significant differences in Vitamin D levels between TB patients and controls.

The prevalence of Vitamin D insufficiency in women with TB (45.30%) was not significantly different from those without TB (p=0.91). Nansera et al. study, which measured Vitamin D and calcium levels in HIV-negative-, HIV-infected- and TB/HIV co-infected adults, also reported individuals with TB/HIV co-infection were usually suffering from severe micronutrient malnutrition due to a combination of TB infection and high viral load. In the present study, oral candidiasis was present in patients with micronutrient deficiency.
Table 5: The odds ratio between demographics, micronutrient levels and Oral Candidiasis (n=88)

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>1.01</td>
<td>0.97 – 1.05</td>
<td>0.698</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0.61</td>
<td>0.24 – 1.52</td>
<td>0.284</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.13</td>
<td>0.42 – 3.09</td>
<td>0.804</td>
</tr>
<tr>
<td>HIV Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>1.12</td>
<td>0.44 – 3.44</td>
<td>0.845</td>
</tr>
<tr>
<td>Zinc Deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 8.2 µmol/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 8.2 µmol/L)</td>
<td>2.25</td>
<td>0.61 – 8.25</td>
<td>0.221</td>
</tr>
<tr>
<td>Vitamin A Deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 1.05 µmol/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 1.05 µmol/L)</td>
<td>0.37</td>
<td>0.13 – 1.07</td>
<td>0.066</td>
</tr>
<tr>
<td>Selenium Deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 46 µg/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 46 µg/L)</td>
<td>11.41</td>
<td>0.12 – 17.11</td>
<td>0.788</td>
</tr>
<tr>
<td>Iron Deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 9 µmol/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 9 µmol/L)</td>
<td>0.75</td>
<td>0.27 – 2.03</td>
<td>0.567</td>
</tr>
<tr>
<td>Albumin Deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 35 g/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 35 g/L)</td>
<td>10.82</td>
<td>0.28 – 2.41</td>
<td>0.724</td>
</tr>
<tr>
<td>Vitamin D Deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 49 nmol/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 49 nmol/L)</td>
<td>2.25</td>
<td>0.61 – 8.25</td>
<td>0.221</td>
</tr>
</tbody>
</table>

Table 6: The odds ratio between micronutrient deficiency and Oral Candidiasis in TB/HIV co-infected (n=61)

<table>
<thead>
<tr>
<th>Micronutrient levels</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt;8.2µmol/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 8.2 µmol/L)</td>
<td>2.25</td>
<td>1.90 -2.40</td>
<td>0.021</td>
</tr>
<tr>
<td>Vitamin A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(&gt; 1.05 µmol/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(&lt; 1.05 µmol/L)</td>
<td>1.50</td>
<td>1.20 -1.80</td>
<td>0.020</td>
</tr>
<tr>
<td>Selenium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 46 µg/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 46 µg/L)</td>
<td>1.40</td>
<td>0.95 -1.50</td>
<td>1.003</td>
</tr>
<tr>
<td>Iron</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 9 µmol/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 9 µmol/L)</td>
<td>0.75</td>
<td>0.55 -1.20</td>
<td>0.570</td>
</tr>
<tr>
<td>Albumin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&lt; 35 g/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 35 g/L)</td>
<td>0.80</td>
<td>0.45 -1.30</td>
<td>0.732</td>
</tr>
<tr>
<td>Vitamin D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (&gt; 49 nmol/L)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (&lt; 49 nmol/L)</td>
<td>2.63</td>
<td>2.45 -3.00</td>
<td>0.022</td>
</tr>
</tbody>
</table>
deficiency and in patients with micronutrient levels within the normal range. Few studies have investigated the relationship between these micronutrients (Vitamin A, Albumin and Vitamin D) and oral candidiasis in TB patients. However, Steenkamp et al.\textsuperscript{5,6} reported a deficiency in micronutrients such as Albumin, Vitamin A and Vitamin D.

Steenkamp et al.\textsuperscript{5,6} also indicated the negative impact HIV and high viral load have on these micronutrient deficiencies, and oral candidiasis has been identified as one of the oral lesions strongly associated with HIV/AIDS\textsuperscript{5,7} and as a marker of immune suppression.\textsuperscript{5,6}

Other different host factors are independently implicated in the development of oral candidiasis. These include old age, treatment with antibiotics, denture wearing and neglected oral hygiene, all of which predispose patients to the occurrence of oral candidiasis.\textsuperscript{5,11}

LIMITATIONS

This study had a few limitations worth highlighting. One was the small sample size of TB patients and another the lack of a control group. These two limitations restricted the ability to draw conclusions about the associations between the independent and dependent variables.

Another limitation was reliance on the self-reported HIV status, necessary as budgetary constraints precluded comprehensive diagnostic testing. However, the self-reported HIV positive status was above the national average\textsuperscript{19} and this is not surprising in the resource-poor setting of Alexandra and the context of widespread co-infection with HIV and TB in South Africa.\textsuperscript{18} Future studies would benefit from much larger sample sizes to draw more convincing conclusions.

This study is, however, a useful starting point for understanding the association between micronutrient deficiency and oral candidiasis in TB patients. More case control studies are needed to investigate the association of micronutrient deficiency and oral candidiasis in TB cases versus non-TB cases.

CONCLUSION

The present study shows a high prevalence of oral candidiasis, especially pseudomembranous oral candidiasis, as well as a high prevalence of several micronutrient deficiencies among adult TB patients.

There was a significant association between the presence of oral candidiasis in TB/HIV co-infected patients and Zinc-, Vitamin A- and Vitamin D- deficiencies. The present findings underline the importance of an oral examination and the need for mineral and vitamin supplements in adult TB patients, especially those who are TB/HIV co-infected.

Acknowledgements

Research Partners

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South African National Tuberculosis Association (SANTA)
City of Johannesburg, Department of Health and Housing
Edmore Miranda, Mazvita Senganyi

References


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Athma Chetty, 53 years, Procurement Administrator, Gauteng

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ORIGINAL. DEPENDABLE. SINCE 1987.³
Dental management of patients with inherited bleeding disorders: a retrospective study

ABSTRACT

Introduction
Minor invasive procedures can precipitate a prolonged bleeding episode in patients who have inherited bleeding disorders (IBD). Protocols have been established to minimize this postoperative bleeding, and the management of dental procedures performed on patients with IBD have been reviewed internationally. This paper undertakes a review of the topic and is probably the first of this nature in South Africa.

Aim and study design
This retrospective study reviewed dental procedures performed over a 16-year period on patients with IBD at the Charlotte Maxeke Johannesburg Academic Hospital (CMJAH), and compared those treatment approaches with published international guidelines.

Methods
The data were extracted from the files of patients seen at the Haemophilia Comprehensive Care Centre (HCCC) and from the Wits Oral Health Centre (WOHC) database at CMJAH.

Results
Dental extractions accounted for 58% of dental procedures performed. Local haemostatic agents were used in 42% of the study population.

Postoperative bleeding was observed in three subjects, and the management of these correlated with the published guidelines.

Conclusion
In this single centre review, bleeding following dental procedures was infrequent. The recommended improvements include greater use of preventive and supportive dental procedures; and administration of local haemostatic agents in invasive procedures.

Keywords
Inherited bleeding disorders; Haemophilia; Von Willebrand Disease

INTRODUCTION
Patients with inherited bleeding disorders (IBD) have an increased risk of bleeding during and after invasive dental interventions, even if the procedures are relatively minor in nature. The intensity and number of bleeds in these patients depend on disease-related factors such as the severity of the bleeding disorder, local and systemic patient-related factors, as well as intervention-related factors. The patient-related factors include gingival inflammation and blood vessel disease (e.g. Raynaud’s phenomenon), whilst the intervention-related factors include the number and type of the teeth extracted, or the surface area of the wound following an extraction. The frequency of bleeding complications after dental treatments in patients with IBDs has been significantly reduced following the introduction of clotting factor...
concentrates, desmopressin (DDAVP) and anti-fibrinolytic agents. Dental procedures should be scheduled to coincide with administration of FRT to minimize the risks of therapies and to decrease the treatment costs.

The administration of DDAVP 30 to 60 minutes before an invasive procedure is clinically effective in patients with a moderate form of haemophilia A (HA) and for those with type 1 Von Willebrand disease (VWD) and some with type 2 VWD. Factor Replacement Therapy should be administered 30 minutes to one hour before invasive dental procedures, and the administration repeated 24 hours after the procedure. An additional infusion for patients with HA and VWD must be administered 12 hours after the procedure.

The use of clotting factor concentrates comes with the challenge that inhibitors or antibodies are developed towards the replacement factor. The use of local haemostatic agents is therefore highly recommended to reduce the risk of postoperative bleeding.

Inappropriate dental management of these patients can potentially lead to dangers including airway obstruction as a result of the continued bleeding leading to blood accumulation in the pharynx. Thus it is important for dental practitioners to be knowledgeable about these conditions and to be aware of the guidelines for the management of affected patients.

The aim of this study was to review the records of dental procedures that were performed on patients with IBDs at the WOHC at the CMJAH over a 16-year period.

The objectives of the study were to report on the details of those dental procedures, the occurrence of sustained bleeding and the management thereof, which protocols were observed and how they compared with those published in the literature, and, finally, to make recommendations where necessary. This appears to be the first review of this nature in South Africa.

METHODOLOGY

Ethical clearance for the study was obtained from the Human Research Ethics Committee of the University of the Witwatersrand, Johannesburg, South Africa (Certificate No. M150425).

The study population comprised all the patients with IBDs referred from the Haemophilia Comprehensive Care Centre (HCCC) at the CMJAH for dental procedures at the Wits Oral Health Centre (WOHC), during the period of January 2000 to December 2015.

The patient data evaluation was retrospective and anonymous and therefore informed consent was not required. Permission to access records at the Haematology unit and the Wits Oral Health Centre was sought and received from the Head of Unit and Head of School.

The IBDs that were included in the study were haemophilia A (HA) and B (HB), Von Willebrand disease (VWD) and other coagulation bleeding diatheses. Patients with inherited platelet disorders, and those with acquired bleeding disorders were excluded from the study as their numbers were generally small in the HCCC and none had undergone dental procedures.

Data were extracted from the HCCC and WOHC patient files and included demographic characteristics, bleeding condition and severity, dental procedure information and replacement therapy, and post-operative bleeding complications. Each eligible patient record was assigned a study number and the data were anonymized. Patients with incomplete file records and missing data relevant to the study were excluded. Data analysis was performed using a statistics programme (STATA). Quantitative data was summarized in tables and figures and described using medians and ranges; counts with percentages.

RESULTS

Study population demographics

A total of 39 of 106 patients from the HCCC met the study inclusion criteria. Only 21 patient files with the complete data set required for the study were available from the WOHC.

The demographic and baseline characteristics of the study population are depicted in Table 1. The majority of the study population was male (81%) and black (52%).

The average age was 26 with a range of 3 to 61 years. The HA patients comprised 48% of the study population, VWD patients made up 33%, HB patients 14%, and only 5% had factor V (FV) deficiency.

Dental procedures performed on IBD patients

Figure 1 presents the dental procedures performed during the period of 2000 - 2015. There were 33 procedures of which 19 (58%) were dental extractions.

One patient (3%) received a scaling and polishing with full mouth debridement (root planing).
**Replacement therapy and anti-fibrinolytics**

Administration of FRT and/or tranexamic acid (TA) in conjunction with the different dental procedures is depicted in Figure 2. Factor Replacement Therapy and TA in a combined administration had been delivered to all the patients who had undergone extractions, in three patients who had received restorative procedures, and in one patient who had undergone extirpation of the pulp and a restorative procedure.

Patients who had undergone scaling and polishing, and one who had undergone fissure sealant placement, did not receive FRT or TA. The administration of FRT was recorded for one subject who had scaling and polishing together with full mouth root planing. Factor Replacement Therapy and TA administration amongst this population was further categorised according to severity (Figure 3). Four subjects who had extractions were of the mild bleeding phenotype, two of moderate intensity, 12 severe, and one case was not specified. TA was administered orally to one subject with unknown severity prior to periodontal probing and plaque control, to one subject with unknown severity prior to scaling and polishing, and to three subjects with moderate severity who had undergone restorative procedures.

**The use of local haemostatic agents**

In terms of the type of anaesthesia used, 70% of the dental procedures were performed under local anaesthesia (LA), while the remainder, all extractions, were undertaken under general anaesthesia (GA).

**Dental extractions**

A total of 74 teeth were extracted during the period of 2000 to 2015, as depicted in Table 2. The average age of IBD subjects who underwent extractions was 17 years, and the average number of teeth extracted per subject was four. A total of 61 teeth were extracted under GA and 13 teeth under LA. The mean average age of subjects who had extractions under GA was nine years, and 27 years for LA. The mean average number of teeth extracted under GA was six, and one under LA.

**The use of local haemostatic agents**

The use of local haemostatic agents was seen only in the subjects who had undergone extractions (Figure 4) and was not specified in 58% of the subjects. The combination of surgicel and suture usage was recorded in 16% of the subjects, the use of suture alone, in 5% of the subjects, and the combination of suture, surgicel and TA gauze compression in 5%.

**Post-operative bleeding**

Post-extraction bleeding complications were experienced in only three extraction subjects, two of whom were severe HA patients and one a mild VWD patient (Table 3). In one of the subjects with severe HA the bleeding was observed 17 days post-extraction of one tooth. The socket of this patient had been treated at the time of the extraction with a combination of suture and surgicel.

The subsequent management of this subject comprised FRT and TA intravenous administration, while TA was also prescribed orally and as a mouthwash. The use of local haemostatic agents was not recorded in the other two subjects with post-extraction bleeding. The severe HA patient had had extraction of eight teeth under GA and experienced bleeding nine days post-extraction. The patient was managed with FRT and TA was administered both intravenously and orally. The mild VWD subject had bleeding two days post-extraction of six teeth under GA, and was managed by oral TA. The severity of the post-operative bleeding could not be established.

**Study limitations**

This was a retrospective study, subject to all the limitations of these investigations, for example inadequate records. Indeed, the lack of complete data meant that a large number of patients were excluded. Nearly a third of the patient population at the HCCC (CMJAH) have medical aid cover and can therefore access dental care privately.

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**Table 2: Dental extraction in IBD patients**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of teeth or age in years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of extracted teeth</td>
<td>74</td>
</tr>
<tr>
<td>Mean per patient (range)</td>
<td>4 (1-14)</td>
</tr>
<tr>
<td>Median</td>
<td>3</td>
</tr>
<tr>
<td>Average age (range)</td>
<td>17 (3-60)</td>
</tr>
<tr>
<td>Teeth extracted under GA</td>
<td>61</td>
</tr>
<tr>
<td>Mean per patient (range)</td>
<td>6 (3-14)</td>
</tr>
<tr>
<td>Median</td>
<td>5</td>
</tr>
<tr>
<td>Average age (range)</td>
<td>9 (3-21)</td>
</tr>
<tr>
<td>Teeth extracted under LA</td>
<td>13</td>
</tr>
<tr>
<td>Mean per patient (range)</td>
<td>1 (1-4)</td>
</tr>
<tr>
<td>Median</td>
<td>1</td>
</tr>
<tr>
<td>Average age (range)</td>
<td>27 (4-60)</td>
</tr>
</tbody>
</table>

*GA: general anaesthesia; LA: local anaesthesia

**Table 3: Post-extraction bleeding complications**

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Local haemostatic agent</th>
<th>Dental procedure</th>
<th>Start of bleeding</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe HA</td>
<td>Suture and surgicel</td>
<td>Extraction of 1 tooth under LA</td>
<td>17 days post procedure</td>
<td>FRT and TA IV + TA PO + TA mouthwash</td>
</tr>
<tr>
<td>Severe HA</td>
<td>None</td>
<td>Extraction of 8 teeth under GA</td>
<td>9 days post procedure</td>
<td>FRT and TA IV + TA PO</td>
</tr>
<tr>
<td>Mild VWD</td>
<td>None</td>
<td>Extraction of 6 teeth under GA</td>
<td>2 days post procedure</td>
<td>TA PO</td>
</tr>
</tbody>
</table>

*HA: haemophilia A; VWD: Von Willebrand disease; LA: local anaesthesia; GA: general anaesthesia; FRT: factor replacement therapy; IV: intravenous; PO: per os; TA: tranexamic acid
Figure 1. Dental procedures performed during the study period (2000–2015).

Figure 2. Use of replacement therapy and/or tranexamic acid categorised according to dental procedure.

Figure 3. Use of replacement therapy and tranexamic acid categorised according to severity of IBD and dental procedure.

Figure 4. Use of local haemostatic agents in IBD patients.
Finally, this study raised an important question of poor liaison between the HCCC and WOHC at the CMJAH, evidenced to some extent by the incomplete records.

DISCUSSION AND RECOMMENDATIONS

A report of the World Health Organization (WHO) states that oral health services in Western industrialized countries comprise preventive and curative services and are available to the general population. The report also states that in many countries in Africa, Asia and Latin-America the majority of services are limited to pain relief or emergency care due to a shortage of oral health personnel.10

The public oral health service in South Africa has been described as palliative and demand-driven, since it lacks a structured budget and operational concepts. There is also a critical shortage of oral health professionals in the public sector which leads to the restricted delivery of dental procedures, with the main focus being extractions.11

This was attributed to a lack of resources (clinical/technical/infrastructure) and a high patient load.11 This pattern of service delivery observation is reflected in this study, where extraction was the most commonly performed procedure, while preventive services were infrequently rendered.

The average age of subjects who had undergone extractions was 17 years, while the average number of teeth extracted per subject was four. This is a cause for concern as this means that there is premature loss of teeth which impacts on the patient’s quality of life.

Dental intervention and promotion of oral health is essential from the early stages of life in order to maintain optimal oral health.12 IBD patients are mostly diagnosed in childhood which provides the ideal opportunity for enrolment in a preventive programme so that the need for future invasive procedures can be limited.

Fissure sealant application is recommended as an effective adjunct to other caries preventive procedures.13-15 A study conducted in Hammanskraal, an area in the Gauteng Province of South Africa with high natural fluoride levels in the water supply, revealed a 75.2% reduction in caries levels amongst 15 year-old children who had twice been treated with fissure sealants over a seven year period.13

This study set out to examine the management of dental patients who suffered inherited bleeding disorders and to assess the protocols followed at WOHC and CMAH in comparison with international standards. The use of replacement therapy, alone and in combination with TA, was observed among the subjects who had undergone extractions, full mouth root planing with scaling and polishing, restorative, and endodontic procedures.

According to the published protocols, extractions and root planing are considered as invasive procedures that are associated with a high risk of bleeding, and therefore require replacement therapy to be administered 30 minutes to one hour before the procedure. This study showed that patients undergoing invasive procedures were managed in accord with the published norms. Restorative and endodontic procedures, however, are associated with a low risk of bleeding, and therefore it is recommended that replacement therapy administration is not required.7,16 However, in this study, some such patients were in fact also managed with replacement therapy (RT).

No replacement therapy or TA was administered in subjects who had undergone scaling and polishing, and fissure sealants. This practice is in keeping with the published protocols. Periodontal probing and supragingival scaling and polishing are unlikely to cause prolonged bleeding.

Management of patients with poor gingival health requires several visits to prevent excessive bleeding.7,16 It is advised that supragingival scaling can be carried out after the gingival inflammation has subsided.16,17 The use of a TA mouthwash after dental scaling in patients with haemophilia has been shown to be as effective in controlling gingival haemorrhage as using FRT.19 This implies that FRT can be reserved for more severe bleeding situations.18

The use of FRT in conjunction with TA or an anti-fibrinolytic agent, as observed in this study, has been described and is supported by literature. Prior to the introduction of viral inactivated plasma derived factor concentrates, the aim in the management of patients with IBD was to reduce the amount of blood products used wherever it was safe to do so, thereby minimising the possibility of transmitting viral infections.

Pursuant to this objective, clot lysis was impeded in a group undergoing extractions by using replacement therapy in conjunction with epsilon aminocaproic acid (EACA), a plasminogen activation inhibitor. EACA was administered IV prior to and post-extraction followed by oral administration four times daily for 10 days.

This treatment approach is effective in the management of patients with IBDs requiring dental extractions, as the frequency of administration and total quantity of concentrates used could be drastically reduced.19 More recently, replacement of recombinant factor has been used to reduce the risk of transmitting blood borne infections.19 However it is expensive and may elicit antibodies which destroy the clotting factor. Whilst replacement therapy in combination with anti-fibrinolytic therapy is more effective in reducing blood loss than the use of FRT alone,7,18 TA is currently the preferred choice because it is more potent than EACA.19

Sixty-one teeth were extracted under GA with the average number of teeth extracted per subject being six, and the average age of subjects at nine years. According to the published protocols GA should be avoided in IBD patients as the procedure can cause a laryngeal haematoma which can lead to upper airway obstruction.3,20 The recommendation is that alternatives to GA, such as anxiolytic agents and appropriate sedation, be explored.6

LA containing a vasoconstrictor reduces the bleeding during the procedure and also promotes local haemostasis.20 However administering the LA may be
associated with a significant risk of haematoma formation, especially involving the inferior alveolar and posterior superior alveolar nerve blocks, lingual infiltration, and floor-of-mouth injections.

FRT with or without TA is necessary prior to these LA techniques being performed. The type of LA and the techniques used could not be reported on in this study due to the relevant information not being included in the patients’ files.

The high fibrinolytic activity in the oral cavity due to saliva and local tissue plasminogen activator (t-PA) production, qualifies the use of haemostatic agents which inhibit this action and assist in minimizing intra-operative and post-operative bleeding.1,16

The agents augment the coagulation cascade, increase the rate of vasoconstriction, seal blood vessels or vascular channels, or promote platelet aggregation.21 Their use is therefore very beneficial, and should not be neglected.7-9

In this study, local haemostatic agents were recorded in only 42% of the study population, in whom it was reserved for extractions.

In the current study TA was used post-operatively alone as a swish and swallow in 11% of the subjects who had extractions, and in conjunction with suture and surgical in 5% of those subjects. The literature recommends using TA mouthwash prior to a dental procedure in which bleeding is anticipated, inclusive of scaling and polishing in individuals with poor gingival health.7,19

Following the use of TA mouthwash, its concentration in saliva was very high after 30 minutes; above 200 micrograms per milliliter, and it remained at a therapeutic level for more than two hours thereafter.22 However, the systemic administration of TA resulted in undetectable salivary levels; hence local administration of an anti-fibrinolytic agent is recommended.19,22

To make up a 5% mouthwash solution, a 500mg TA tablet is crushed and dissolved in 10ml water. TA mouthwash should be swirled in the mouth for 2-3 minutes and either swallowed or expelled. Children should be supervised to ensure that the rinse is expelled to avoid exceeding the recommended dose. This should be done at least 30 minutes before the procedure, and continued six hourly for 7-10 days.7

Management protocols for extraction or surgical sites differ, and include the use of two 500mg ampoules of TA to irrigate the socket or surgical site prior to suturing.9 Franchon et al. described a different approach in which the site is cleansed, and a combination of fibrinogen-based biological glue and calcium thrombin is inserted.

This is followed by the insertion of a resorbable gelatin packing, which is then covered with a layer of biological glue. Resorbable sutures are placed and covered with another layer of biological glue. Intermittent TA compressions are applied after the procedure and for the first three days after the procedure, repeated one hourly on the first day, two hourly on the second day and three hourly on the third day.20

The recommendation is that local haemostatic agents should be used as described in the literature. A protocol for the management of extraction or surgical sites should be put in place to ensure uniformity in the management of patients.

Even with careful preoperative planning, postoperative bleeding may occasionally be seen.16 In the aforementioned study by Franchon et al. post-extraction bleeding was observed at minimum on day one, and at most on day eight in six of the 19 patients that had extractions, despite the extraction site management protocol having been instituted.20

In the current study postoperative bleeding was observed in three subjects who had extractions performed. In only one of these subjects was a local haemostatic agent applied, and we may attribute the post-extraction bleeding to factors such as lack of home care or patients not following postoperative instructions. The post-extraction bleeding observed in the other two patients could possibly be attributed to the lack of local haemostatic agents.20

Management of post-extraction bleeding includes administration of additional systemic haemostatic therapy, repeated local compression, and the use of a local anaesthetic containing a vasoconstrictor.4,20 The protocols for the management of post-operative bleeding correlated with those published.

CONCLUSION

Successful dental management of patients with IBD must be a joint approach between the dentist and haematologist.7,23 Most of the protocols for the dental management of IBD patients observed in this study are similar to those that are published and used internationally.1-9 Some of the recommended improvements include the greater use of preventive and supportive dental procedures, local haemostatic agents and the use of LA instead of GA.

A standard protocol for the dental management of IBD patients should be formulated and put in place in CMUAH WOHC and at similar facilities to ensure uniformity in the management of IBD patients, and to ensure alignment with internationally accepted norms.

References


ERRATUM

Sadly, the Journal has incorrectly recorded the name of one of our authors and an apology is sincerely extended. The article appeared in the June 2018 issue under the title: “Early childhood caries experience of children accessing selected immunization facilities in Johannesburg.”

The name of the first author was recorded as NP Molete and a first name of Primrose appeared. The name correctly should have been MM Molete with first names Mpho Matlakale.

Figure 1 showed an arrow slanted at an angle... this should have been horizontal, not angled.

The Journal regrets these errors and thanks Dr Molete for drawing attention to the glitches.
Root canal treatment in mandibular canines with two roots: a review of the literature and a report of three cases

ABSTRACT

Endodontic treatment may sometimes fail because the morphological features of the tooth can adversely affect the treatment procedures. Mandibular canines can present with complex internal anatomy and many investigators have reported associated anatomical variations.

This paper describes three clinical case reports of mandibular canines, each with two roots and two canals. In addition, the prevalence, aetiology, root morphology and the clinical and radiographic diagnoses for mandibular canines that present with this anatomical variation will be discussed.

INTRODUCTION

Root canal treatment on a tooth is performed with the intention of eliminating any infection and preventing the possibility of re-infection in the root canal system.\(^1\)

The configuration of the root canals of any tooth can be complex and when treatment fails to locate, clean, shape and obturate them effectively, complications can arise. These include post-operative pain and disease in the affected tooth and surrounding structures.\(^1-3\)

Numerous factors can contribute to the failure of endodontic treatment and may include persistent infection in the root canal (which was not eliminated at the initial treatment phase), inadequate approach to cleaning and shaping (leading to poor root canal preparation), broken instruments and incomplete obturation of the prepared root canal.\(^4\)

It is evident that a thorough knowledge of root canal anatomy is needed as well as the anticipation of possible variations associated with each tooth are vital to ensure a more predictable prognosis with the completed treatment.\(^5\)

The canine is considered to be the “cornerstone” of the dentition and plays a vital role in mastication because of its morphology and its location in the oral cavity.\(^6\)

Practitioners should take into consideration that although the mandibular canine usually has one root with a single root canal\(^6-8\) the possibility exists that there may be more than one canal. However, the anatomy of the root canals does not necessarily correlate with the shape of the tooth.

In other words, a treating clinician must be careful not to always assume a standard presentation with one root and one canal, as the mandibular canines can display different anatomical variations.\(^9\) An early study by Nair et al. concluded that root canal morphology plays a crucial role in endodontic treatment and could greatly influence successful outcomes.\(^10\)

A great number of clinicians have the conception that a given tooth will inevitably contain a precise and regular number of root canals and roots. Unfortunately, careful consideration of the available literature reveals that variations of tooth morphology are indeed common, and this includes the mandibular canine.\(^4,7,11-14\)

PREVALENCE OF ROOT CANALS IN MANDIBULAR CANINES

The mandibular canine is generally considered a tooth with mono-radicular morphology and a single root canal.\(^6-8\) This is not always the case. The reported incidence of two root canals in a mandibular canine with one root varies between 1% and 15%,\(^7,8,11-13\) with minor differences in findings between authors.

A further variation includes the mandibular canine with two roots and two root canals, having an incidence of up to 12.08%.\(^6,15-17\) Another rare configuration was reported by Heling and co-workers, who treated a mandibular canine with two roots and three canals.\(^14\)
AETIOLOGY OF MANDIBULAR CANINES WITH TWO ROOTS/TWO CANALS

An investigation of the literature revealed that the incidence of mandibular canines with two canals and/or two roots might be higher in certain populations and races than in others. Studies conducted by means of diverse methodologies have focused on different populations and races in different parts of the world. A review of the literature available at the time (1963) summarised the results of various studies determining the presence of a second root in mandibular canines in a variety of populations (Table 1, below).

More recent literature has revealed similar results. An incidence of 1.7% of mandibular canine teeth with a second root was found in a Brazilian survey of 830 mandibular canines (Table 1). A recent study of an Iranian population discovered a relatively high number of two-rooted mandibular canines (18 out of 149 teeth), the highest incidence recorded (See Table 1).

The studies conclude that different genetic models exist among different races and populations, which influence the morphological appearance of all teeth. According to the findings of the studies, it can be speculated that different genetic models can invoke a higher incidence of two or more canals and/or roots in mandibular canines.

EXTERNAL ROOT MORPHOLOGY

The root morphology of the mandibular canine is very similar to that of other teeth, but larger. The root is wider in diameter from buccal to lingual compared with mesial to distal dimension.

Developmental depressions can be observed on the mesial and distal surfaces of the root. According to various authors these depressions can be deep and may create the appearance of a bifurcated root or a second root.

An actual bifurcation may occur at the cervical, middle, or apical third of the root surface. Sharma et al. (1998) concluded that the most common area of bifurcation occurred at the apical third (56.9%), followed by the middle third (40%), and finally the apical third (3.1%). This anatomical aberration can be bilateral according to certain studies and case reports. Sharma and co-workers also measured the average lengths of the buccal and lingual roots of 65 mandibular canines with two roots. It was found that the average length of the buccal roots was 23.0 mm and of the lingual roots, 22.7 mm.

In 47.7% of the teeth investigated, the buccal roots were longer than the lingual root and 43.1% of teeth possessed buccal and lingual roots of equal length. Taylor analysed the size ratio between the labial and lingual roots of 179 mandibular canines with an additional root.

Three variations could be observed in the investigation; these were: (1) 65.3% with proportional buccal and lingual roots; (2) 27.4% with a greater diameter of the labial root compared with the lingual root; and (3) 7.3% with the lingual root displaying a greater diameter than that of the buccal root.

RADIOGRAPHIC DIAGNOSIS

Intraoral radiographs have traditionally been seen as invaluable in assessing the internal anatomy of teeth. In cases where multiple canals or additional roots are suspected, radiographs taken from different angles can increase the diagnosis of hidden anatomy and potential challenges. Radiographic images should be carefully studied and analysed in an effort to detect any detail suggesting root morphology with bifurcations or trifurcations. An apparent sudden discontinuity of a root canal pathway might also indicate hidden anatomy.

The use of periapical radiographs has certain disadvantages, which include superimposition of anatomical structures and a limited two-dimensional image. These factors reduce the diagnostic potential of the radiographs in cases of unusual anatomy.

In recent years, Cone Beam Computed Tomography (CBCT) imaging has become a standard tool in the field of endodontics for identifying suspected variations in tooth form, curvatures, and bifurcations. CBCT imaging offers the benefit of three-dimensional views as compared with the traditional two-dimensional periapical radiographs.

<table>
<thead>
<tr>
<th>Author</th>
<th>Ethnic Group</th>
<th>Number of lower canine teeth</th>
<th>Number of lower canine teeth with two roots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillebrand (1909)</td>
<td>Hungarians</td>
<td>1707</td>
<td>103 (6%)</td>
</tr>
<tr>
<td>Schwerz (1916)</td>
<td>German</td>
<td>507</td>
<td>31 (6.1%)</td>
</tr>
<tr>
<td>Fabian (1928)</td>
<td>German</td>
<td>315</td>
<td>20 (6.4%)</td>
</tr>
<tr>
<td>Hjelmman (1929)</td>
<td>Finnish</td>
<td>98</td>
<td>5 (4.9%)</td>
</tr>
<tr>
<td>Shaw (1931)</td>
<td>South Africans</td>
<td>62</td>
<td>1 (1.6%)</td>
</tr>
<tr>
<td>Visser (1948)</td>
<td>Dutch</td>
<td>2488</td>
<td>123 (4.9%)</td>
</tr>
<tr>
<td>Pedersen (1949)</td>
<td>Inuit (Greenland)</td>
<td>72</td>
<td>1 (1.3%)</td>
</tr>
<tr>
<td>Huche (1954)</td>
<td>French</td>
<td>282</td>
<td>28 (10%)</td>
</tr>
<tr>
<td>Pécora et al. (1993)</td>
<td>Brazilian</td>
<td>830</td>
<td>14 (1.7%)</td>
</tr>
<tr>
<td>Rahimi et al. (2013)</td>
<td>Iranian</td>
<td>149</td>
<td>18 (12.1%)</td>
</tr>
</tbody>
</table>
Areas of interest can be viewed on three different planes, and the combination of sagittal, coronal and axial views eliminates the interference of superimposition of anatomical structures that can obscure hidden anatomy, including additional root canals or roots. Assessment of a CBCT also offers the potential to determine tooth lengths in axial and sagittal planes more accurately than is possible on standard radiographs.

**CLINICAL DIAGNOSIS**

The clinical diagnosis and location of additional canals or roots can be a challenge for clinicians who are urged to approach each endodontic treatment of a mandibular canine (even if it appears to be single rooted) with the mind-set that two canals are present until proven otherwise. The use of magnification can also be beneficial during treatment. Magnification loupes or the Dental Operating Microscope (DOM) have the potential to assist the operator in the location of additional canals. Yousef and Abdullah concluded in a very recent case report that in the re-treatment of a left mandibular canine with two roots, the DOM played an indispensable role in the location of a missed root canal system.

Magnification should form part of an integrated approach in conjunction with sharp endodontic explorers to reveal hidden orifices and altered access preparations to improve vision. The treatment of diverse anatomy in mandibular canines can also be a challenge to the clinician.

The long axis of the buccal canal passes through the surface of the crown very close to the incisal edge or on the labial surface. In an effort to locate the lingual canal orifice, a small pre-curved hand file should be used after initial scouting with sharp endodontic explorers.

**Case Report 1**

A 55-year-old male patient presented with irreversible pulpitis on his mandibular right canine. A periapical radiograph revealed evidence of a two-rooted canine (Figure 1a). After preparation of a conventional access cavity it was possible to locate only the buccal root canal system (Figure 1b).

A limited field-of-view CBCT scan was taken to help with location of the lingual root canal system. Figure 1c shows a coronal view of the CBCT scan clearly illustrating the two roots and two root canals of the canine, bifurcating in the middle of the root.

After several attempts to locate the lingual root canal system, it was realized that the access cavity had to be lengthened extensively towards the lingual and gingival aspect of the tooth in order to facilitate the search (Figure 2a).

A periapical radiograph was used to confirm working lengths in the buccal and lingual root canals (Figure 2b, below). After glide path preparation with a ProGlider (Dentsply Sirona) the canals were prepared to full working length using the X1 and X2 ProTaper Next instruments (Dentsply Sirona).

The prepared canals were irrigated with 17% EDTA and heated 3.5% sodium hypochlorite before they were obturated with the use of two X2 ProTaper Next Gutta Percha Points (Dentsply Sirona) in combination with Pulp Canal Sealer (Kerr) and the Calamus Dual Obturation Unit (Dentsply Sirona). Figure 2c (below) depicts the post-operative result after canal obturation.

**Case Report 2**

The patient, a 51-year-old male, presented with a non-vital mandibular right canine. A pre-operative periapical radiograph revealed a large root canal system in the coronal aspect of the tooth before the canal bifurcated (Figure 3a, p510).

A limited field-of-view CBCT scan confirmed that there were two separate roots with two root canals bifurcating just below the middle of the tooth (Figure 3b, p510).

After examination of the scan, an access cavity was prepared on the labial aspect of the tooth to provide straight-line access into the two root canal systems.

After glide path preparation the canals were prepared with the Primary 25/07 WaveOne Gold file. After irrigation, two Primary WaveOne Gold Gutta-Percha Points were fitted (Figure 4a, p510) and verified radiographically.

Figure 4b (p510) shows the final result after root canal obturation and the access cavity having been closed with SDR, posterior bulk fill flowable base (Dentsply Sirona) and capped with a final layer of Ceram.x SphereTEC one composite resin (Dentsply Sirona). A coronal slice of a four-month follow-up CBCT scan showed good healing of the periapical pathology (Figure 4c, p510).
In the first step, “Diagnosis and Pathology”, the imported scan was reviewed in the axial, sagittal and coronal planes. The software has the ability to present a 3D reconstructed view in which the transparency of the images of the teeth can be changed (Figure 6).

In the next step, “3D Tooth Anatomy”, the canine was selected and the entire volume was cropped to leave only the data of interest (Figure 7a). In Step 3, “Canal System”, the number of root canals was identified and each root canal was then mapped separately by identifying the orifice and radiographic apical foramen of each root canal.

The patient, a 47-year-old female, presented with non-vital mandibular right lateral incisor and canine teeth (Figure 5, below). A preoperative limited field-of-view CBCT scan revealed that the canine had two roots and two canals bifurcating in the apical third of the tooth. The lingual canal bifurcated at an approximate 60-degree angle from the main central root canal system.

Owing to the complex appearance of the root canal anatomy of this tooth the anatomy was explored further in 3D Endo Software (Dentsply Sirona). The software allows the clinician to perform pre-endodontic treatment planning of simple and complex endodontic cases, using DICOM (Digital Imaging and Communications in Medicine) data from a CBCT scan. The benefit and value of this software have been illustrated in previous publications.40,41

The 3D planning of the case was done following five easy steps detailed in the software program.

In Step 4, “3D Canal Anatomy”, the software made a proposal of the canal anatomy and corrections were made according to the canal configuration after viewing in different planes by manipulating the software.

At the final step, “Treatment Plan”, the software projected ISO size 06 instruments into the canals, which allowed both visualisation of the internal anatomy of the canals and the checking of straight-line access. This view was also rotated in 3D to alert us about the angle and direction of curvatures in the root canal systems. Figures 8a, and 8b (p511) present a view of the file curvatures for a conventional lingual access cavity preparation compared with a modified labial access cavity, respectively.

These simulations illustrate the lowest stress on the instruments during glide path preparation and canal preparation when a labial access cavity is prepared.
A master file can also be selected from a preloaded database of endodontic file systems. On the basis of the S-shaped curvatures in the lingual root canal system a decision was made to use the Small WaveOne Gold file (20/07) for root canal preparation in both canals (Figure 8c).

The selected instruments were then displayed in the root canal systems and these images could have also been digitally rotated to enable the operator to visualise the root canal anatomy in 3D.

The findings of the 3D Endo Software were taken into consideration and an access cavity was prepared on the labial aspects of both teeth. It was very easy to locate both canals in the canine as a result of the straight-line access obtained from the labial access cavity (Figure 9a).

**Figure 6.** The software projection of ISO size 06 instruments into the canals, which allows the operator to visualise the internal anatomy of the root canals. (a) View of the file curvatures for a conventional lingual access cavity preparation; (b) view of the file curvatures for a modified labial access cavity; (c) Two WaveOne Gold Small files selected from a preloaded database of endodontic file systems and projected in the root canal systems.

After glide path preparation with the reciprocating WaveOne Gold glider (Dentsply Sirona), the two root canals in the canine were prepared with a Small 20/07 WaveOne Gold file and the single canal in the lateral incisor was prepared with a Primary 25/07 WaveOne Gold file.

After irrigation, WaveOne Gold Gutta-Percha points were fitted and verified radiographically. Figure 9b shows the final result after root canal obturation of the two root canals in the canine and the single root canal in the lateral incisor.

**Figure 9.** (a) Location of both root canals in the two-rooted canine tooth; (b) periapical radiograph showing the result after root canal obturation of the two root canals in the canine and the single root canal in the lateral incisor; (c) 30-degree mesial angulated radiographic view of the canine showing the two obturated root canals in the canine, as well as two lateral canals branching off from each root canal system.

A 30-degree mesial angulated radiographic view of the canine shows the two obturated root canals, as well as the two lateral canals branching off from each root canal system (Figure 9c, below).

The mandibular canine is considered to be the second longest tooth in the dentition, the maxillary canine being approximately 1 to 2 mm longer from the incisal edge to the most apical point. Clinical observation of mandibular canines has revealed a second root in some cases, which creates a unique morphology of a mandibular anterior tooth with a buccal and lingual root.

An important fact to consider, then, is that often two canals can be present in the lower canine and that, often but not always, these canals join into a single root canal system before exiting at the apex. A further relevant anatomical feature is that the root canal of the mandibular canine appears to be flatter compared with its counterpart in the maxilla.

As discussed earlier, variations in the morphology of the mandibular canine exist and the available literature has even reported variations between populations. Morphological variations (including the two-rooted mandibular canine) can present severe endodontic challenges during cleaning, shaping and obturation.

The first step needed for proper cleaning and shaping of the root canal system is adequate access. Proper access also ensures excellent 3D obturation. In Case Report 2 of this study, endodontic access was gained through the labial surface of the tooth. Endodontic access cavities through the labial surface (rather than the traditional approach from the lingual side) may contribute towards the achievement of proper disinfection of root canal systems of lower anterior teeth.

Mauger and co-workers observed proper straight-line access in 179 teeth. These authors concluded that in 27.6% of lower anterior teeth, ideal straight-line access was present slightly labial of the incisal edge.

The remaining 72.4% of observed teeth indicated ideal straight-line access through the incisal edge. According to the findings of their study, no straight line access was possible through the lingual surface.

A buccal approach ensures conservation of valuable tooth structure near the cingulum area. An effort to retain tooth structure in this area is vital for strength of the clinical crown, the prevention of fractures and ultimately ensuring longevity of the endodontic treatment. Labial access preparations often do create challenges with regard to aesthetics, but modern restorative approaches and available materials ensure a more predictable outcome.

Radiographic imaging plays a vital part in diagnosis, treatment planning and follow up of modern endodontics. High-resolution CBCT images are ideal for the diagnosis of periapical lesions, the identification of root fractures, resorption lesions, the evaluation of root canal morphology, root length and root curvatures.
In addition, Dentsply Sirona recently introduced 3D Endo Software to the endodontic community. This remarkable innovation allows the clinician to perform pre-endodontic treatment planning of simple and complex endodontic cases. Digital Imaging and Communications in Medicine (DICOM) data from a CBCT scan is used to create a 3D image. Further benefits of the software are the identification of anatomical complexities, access cavity design, working length measurement, and identification of canal curvatures. 41

The planning of endodontic cases in 3D has proved to be a major step forward for predictable modern endodontics. 40

3-D imaging can also aid in the prevention of procedural errors, especially encountered in complex cases. 40

The benefits of 3D Endo Software were demonstrated in Case Report 3. The software system proved to be a vital tool for pre-operative planning and also reduced complications during the procedure. The system allowed the creation of an ideal access cavity preparation, as well as the selection of the appropriate endodontic file system needed to obtain a predictable result.

CONCLUSIONS

The case reports in the study demonstrate a novel approach to cleaning, shaping and obturation of the mandibular canine with two roots and two root canals. Case Report 1 illustrates traditional access on the lingual surface. Case Reports 2 and 3 illustrate the benefit of the buccal approach to access and the incorporation of 3D endodontic software. A combination of altered endodontic access and innovative endodontic technology is an important consideration in the approach to treatment of mandibular canines with altered morphology.

References

Do the CPD questionnaire on page 536

The Continuous Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

Online CPD in 6 Easy Steps

1. Go to the SADA website www.sada.co.za.
2. Log into the ‘member only’ section with your unique SADA username and password.
3. Select the CPD navigation tab.
4. Select the questionnaire that you wish to complete.
5. Enter your multiple choice answers. Please note that you have two attempts to obtain at least 70%.
6. View and print your CPD certificate.
Oral health status of sentenced offenders in KwaZulu-Natal province

SADJ September 2018, Vol. 73 No. 8 p514 - p519

M Radebe¹, S Singh²

ABSTRACT

Objective
To assess the oral health status, knowledge, attitude and practice of sentenced offenders in KwaZulu-Natal correctional centres.

Methods
Simple random sampling selected 373 offenders from nine correctional centres in KwaZulu-Natal, South Africa. Data were collected using a closed-ended structured questionnaire, collated and analyzed using the Statistical Package for Social Sciences (SPSS) version 24.

Results
One hundred and sixty-one (43.2%) were aged 18-29, 144 (38.6%) in age group 30-39, 52 (13.9%) in group 40-49 and 16 (4.3%) were older than 50 years. Over two thirds of the study participants (72.7%) reported brushing teeth twice daily.

Oral health was perceived as poor by 292 (78.3%) offenders. Common self-reported dental problems were caries, bleeding gums, loose teeth and sensitive teeth. Cigarette smoking was prevalent and relatively high among offenders older than 50 years.

Conclusion
Special attention is required from the Department of Correctional Services and the public oral health sector to meet the basic oral health needs of this population. A preventive-oriented oral health care system can synergistically complement other existing services offered in correctional facilities such as the smoking cessation programme. The prevalence of oral diseases of this vulnerable population can be drastically reduced.

INTRODUCTION

Numerous studies conducted in correctional centres in South Africa, India and United Kingdom have shown that prisoners have poor oral health conditions, particularly reflected in the high number of lost and untreated decayed teeth.¹ ²

In addition to this, the health status of prisoners is not usually incorporated into data and reports that summarize the state of the nation’s health, leading to a lack of planned health services for them by the relevant health bodies.³

The available research indicates that most correctional institutions are failing to provide effective and consistent care to offenders under constraints such as security restrictions and resource availability.⁴ The inability to offer consistent care to offenders is further exacerbated by overcrowding which has been identified as a feature of most centres worldwide and continues to pose a major challenge for the relevant Department of Correctional Services.⁵

The South African Department of Correctional Services (DCS) reported at the end of the 2015/2016 financial year that the total inmate population was 161,984, with an approved bed space of 119,134, which translated to an occupancy rate of 135.96%. Of the total, 72.06% were sentenced offenders and 27.94% were unsentenced offenders.

Currently, in KwaZulu-Natal province there are 42 correctional centres with an actual inmate population of 29,253 and an approved bed space of 16,550, which translates into 176.176% occupancy rate.⁶

Clearly, South African correctional institutions are overcrowded. Given the challenges associated with overcrowding, the Department of Correctional Services in SA is plagued by an acute paucity of information reporting on the oral health status of offenders.¹ The only available dental research involving offenders is a baseline survey which was conducted in the Western Cape Correctional centres. Currently, there are no available data on oral health records for sentenced offenders in KwaZulu-Natal province.

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ACRONYM

DCS: South African Department of Correctional Services
Therefore, this study was conducted with an aim of assessing the oral health status, oral health knowledge, attitude and practice of sentenced offenders in KwaZulu-Natal correctional centres.

METHODS

This study was quantitative in design. The sample comprised incarcerated offenders (n=373) who were randomly selected from nine correctional institutions located in the following district municipalities of KwaZulu-Natal province (Zululand, uMzinyathi, uThukela, uMgungundlovu, iLembe, eThekwini, Ugu and Sisonke).

Excluded from the study were sentenced offenders who were below 18 years of age and those who did not give consent to participate. A closed-ended structured questionnaire was administered to assess socio-demographic information; frequency of tooth brushing; type of dental treatment received during incarceration; self-perceived need for dental treatment; attitudes and behaviour scores among offenders regarding oral health; past/present dental attendance and treatment, and smoking prevalence among offenders.

Frequency of tooth brushing was scored on a 3-point scale, ranging from less than once a day to more than once a day (twice or three times). Type of treatment received during incarceration-variable was scored on a 6-point scale, ranging from extraction, filling, scaling and polishing, crown and bridge, root canal to none.

Internal consistency was assessed using the Cronbach’s alpha (α) coefficient which was considered adequate when α ≥ .841 and all data analyses were conducted in SPSS version 24. Descriptive statistics was utilised to investigate any possible relationship between the variables.

When the distribution of scores of the outcome data did not approximate the normal distribution, a non-parametric statistical test viz. Kruskal-Wallis test, was conducted to investigate these relationships further. Statistical significance was noted only when the p-value was less than 0.05.

The Biomedical Research Ethics Committee of the University of KwaZulu-Natal (BE046/15) approved the study and ethical guidelines were followed to ensure confidentiality in the management of data. Gatekeeper permission was obtained from the Department of Correctional Services Research Ethics Committee.

Participants were given clear explanations about the purpose of the survey. All the sentenced offenders aged 18-75 years who were willing to give consent were eligible to participate in the study.

After obtaining permission from the correctional service authorities and participants, the general demographic information data, which included variables such as gender, age and race of the sample were collected by the researcher. The questionnaire was piloted with 37 participants in Greytown Correctional Centre who were later excluded from the main study.

RESULTS

A total of 373 study participants were recruited in the survey, 333 (89.28%) being male and 40 (10.72%) female. The overall response rate was 100 per cent.

Ninety-eight percent of the participants (n=364) described themselves as black and the remainder comprised coloureds (n=5) and individuals from Caucasian (n=2), Indian (n=2) backgrounds.

Two hundred and eleven participants (56.6%) were incarcerated in correctional centres located in urban areas, one hundred and seven participants (28.7%) in peri-urban areas and fifty-five (14.7%) participants in rural areas. Distribution of the offenders according to age and gender is presented in Figure 1 (below).

Table 1 (p516) depicts the distribution of attitudes and behaviour scores among offenders in KwaZulu-Natal correctional centres regarding oral health. Generally, 68.3% of 18-29 year-olds and 93% of participants older than 50 years brushed their teeth at least once a day. About 76.7% of offenders incarcerated in urban areas brushed their teeth at least twice a day, while 65.5% offenders in rural areas practiced the same pattern, a less frequent practice when compared with urban offenders.

Overall, more than two thirds of the study participants (72.7%) reported brushing their teeth twice daily. Response to questions about the utilisation of dental health care services before incarceration revealed that 236 participants (63.3 %) could be regarded as regular users of the dental facilities, while 137 (36.7%) participants had not seen a dentist at all in their communities.

Of those who had visited the dentist, 34 (9.1%) had had their last dental consultation more than five years ago. A recent dental visit was more often reported among participants older than 50 years (43.8%), a statistic slightly higher than for the 18-29 year-olds, which was at 42.2%. Regarding the service availability and access during incarceration, more than two thirds of the study sample 238 (63.8%) reported that it was difficult to obtain a dental
Table 1: Distribution of attitudes and behaviour scores among offenders regarding oral health

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Table 2: Summary of the utilisation of dental services in correctional centres among the offenders

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7. What has been your experience when receiving oral treatment?

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8. Currently what preventive services are offered in correctional centre?

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<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>18-29</td>
<td>161</td>
<td>100</td>
<td>373</td>
</tr>
<tr>
<td>30-39</td>
<td>144</td>
<td>100</td>
<td>373</td>
</tr>
<tr>
<td>40-49</td>
<td>52</td>
<td>100</td>
<td>373</td>
</tr>
<tr>
<td>50+</td>
<td>16</td>
<td>100</td>
<td>373</td>
</tr>
</tbody>
</table>

9. Please identify oral health problems you’re currently experiencing

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Total</th>
<th>Dental Caries</th>
<th>Bleeding</th>
<th>Oral Lesions</th>
<th>Loose Teeth</th>
<th>Sensitive teeth</th>
<th>None of the above</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>18-29</td>
<td>84</td>
<td>52.2</td>
<td>30</td>
<td>18.6</td>
<td>2</td>
<td>1.2</td>
<td>53</td>
</tr>
<tr>
<td>30-39</td>
<td>50</td>
<td>34.7</td>
<td>34</td>
<td>23.6</td>
<td>1</td>
<td>3.1</td>
<td>38</td>
</tr>
<tr>
<td>40-49</td>
<td>20</td>
<td>38.5</td>
<td>14</td>
<td>26.9</td>
<td>0</td>
<td>4.3</td>
<td>15</td>
</tr>
<tr>
<td>50+</td>
<td>9</td>
<td>16.3</td>
<td>5</td>
<td>10.2</td>
<td>0</td>
<td>6.3</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>163</td>
<td>43.7</td>
<td>83</td>
<td>22.3</td>
<td>2</td>
<td>5.5</td>
<td>85</td>
</tr>
</tbody>
</table>

Table 3: The distribution of study participants according to smoking status

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Total</th>
<th>Yes</th>
<th>Total</th>
<th>No</th>
<th>Total</th>
<th>I have never smoked</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>18-29</td>
<td>104</td>
<td>64.6</td>
<td>97</td>
<td>67.4</td>
<td>36</td>
<td>69.2</td>
</tr>
<tr>
<td>30-39</td>
<td>97</td>
<td>67.4</td>
<td>36</td>
<td>69.2</td>
<td>56</td>
<td>40.3</td>
</tr>
<tr>
<td>40-49</td>
<td>36</td>
<td>36</td>
<td>56</td>
<td>40.3</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>50+</td>
<td>12</td>
<td>12</td>
<td>56</td>
<td>40.3</td>
<td>10</td>
<td>6.3</td>
</tr>
<tr>
<td>Total</td>
<td>249</td>
<td>66.8</td>
<td>170</td>
<td>43.2</td>
<td>124</td>
<td>32.8</td>
</tr>
</tbody>
</table>

11. During the past year (12 months), have you ever tried to stop smoking?

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Total</th>
<th>No, I have not tried to stop smoking</th>
<th>Yes, I have tried to stop smoking</th>
<th>I have never smoked</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>18-29</td>
<td>91</td>
<td>56.5</td>
<td>48</td>
<td>33.3</td>
</tr>
<tr>
<td>30-39</td>
<td>17</td>
<td>10.6</td>
<td>32</td>
<td>20.8</td>
</tr>
<tr>
<td>40-49</td>
<td>53</td>
<td>32.9</td>
<td>38</td>
<td>33.3</td>
</tr>
<tr>
<td>50+</td>
<td>16</td>
<td>12.5</td>
<td>25</td>
<td>15.6</td>
</tr>
<tr>
<td>Total</td>
<td>217</td>
<td>58.2</td>
<td>121</td>
<td>32.4</td>
</tr>
</tbody>
</table>
appointment due to a long waiting list. Table 2 (p517) illustrates the utilisation of dental services in correctional centres among the offenders. The results reveal that the participants held in rural correctional centres had higher extraction rates (78.2%) when compared with peri-urban (66.4%) and urban centres (73.5%).

A total of 203 (54.4%) study participants were generally satisfied with the services they had received in the correctional centres. It was noted that there were no oral health educational programmes offered to the participants in any of the centres across KZN province.

The results of the current study also revealed that a total of 292 (78.3%) offenders perceived their oral health as poor and the common self-reported dental problems experienced in correctional centres were dental caries, bleeding gums, loose teeth and sensitive teeth. Lastly, the age group stratification revealed that participants older than 50 years had more dental caries, loose teeth and sensitive teeth than did 18-29 year-olds.

The distribution of study participants according to smoking status is shown in Table 3 (p516). A total of 249 (66.8%) participants reported they were regular smokers. When smoking patterns were further analysed it was discovered that this habit was relatively high (75%) among participants older than 50 years and decreased to 64.6% among 18-29 year-olds. Lastly, it was observed that only 9.4% of the regular smokers had attempted to quit smoking and 58.2% did not have a specific reason to quit, as they were still smoking.

**DISCUSSION**

This cross-sectional study provides a unique opportunity for analysing the state of oral health care services and prevention interventions provided by correctional facilities in KwaZulu-Natal. Participants in this study were stratified into subgroups and differentiated based on traits that were considered relevant by the researchers such as gender, race and age. In the study sample, males were significantly over-represented.

Harlow showed that prison inmates are demographically different from their non-incarcerated counterparts. By gender, male inmates tend to be overrepresented (96 percent); by racial category, ethnic groups dominate the population (62 percent); and by age, younger adults outnumber the middle-aged group (66 percent).

Similarly, a demographic analysis of inmate population by Sifunda et al. revealed that male offenders were alarmingly overrepresented in KZN correctional centres. Authors have argued that men commit a much higher percentage of the most serious and violent crimes and these crimes are most likely to lead to arrest and imprisonment and result in longer periods of imprisonment.

Regarding oral hygiene practices, the majority of the respondents in the present study reported brushing their teeth twice or three times a day. This is comparable to results obtained in a study conducted by Vainionpää et al., where twice a day tooth brushing seemed to be an established practice.

Despite the fact that the majority of the study participants stated that they were brushing their teeth more frequently, it was noted that more than two thirds reported that they were suffering from gingival bleeding and untreated dental caries. This finding is in agreement with a study which was conducted by Akaji and Ashiwaju who found that caries experience of offenders incarcerated at Enugu Federal Prison in Nigerian correctional centre was high and their periodontal health was compromised.

Regarding the use of dental services, less than a third of the participants reported that they had never seen a dentist in their lives. Of those who had consulted with a dentist, the main reasons for such appointments were seeking emergency dental services such as dental extractions and pain relief.

This trend was observed in a study conducted by Nobile et al., where incarcerated offenders had one or more teeth extracted due to caries, the process continuing and eventually rendering a large number of subjects edentulous.

In the present study, cigarette smoking was prevalent among study participants and it was discovered that this habit was relatively high among offenders older than 50 years. Similar trends have been observed in a study conducted by Akaji and Folaranmi which involved offenders of the Nigerian Federal prison in Enugu.

Tobacco use by prison inmates is quite common, indeed is an integral part of their life. It serves a range of functions in prison; as a surrogate currency, a means of social control, as a symbol of freedom in a group with few rights and privileges, a stress reliever, and as a social lubricant.

The use of tobacco has been associated with, loss of periodontal attachment, increased pocket depths, loss of alveolar bone and higher rates of tooth loss. It is therefore incumbent upon officials representing Correctional Services to strengthen smoking cessation programmes in correctional institutions in order to circumvent the negative effects of smoking among this disadvantaged population.

Regarding oral health promotion programmes, most respondents pointed out that there were no such organised programmes in the correctional centres in KwaZulu Natal. The study conducted by Sifunda et al., in South African correctional centres highlighted prevention programmes as an area that required stronger emphasis to facilitate imparting skills to inmates.

Although, Sifunda et al. made recommendations to the DCS to pay special attention to the preventive healthcare programmes in order to improve the lives of offenders during incarceration, the current study found that preventive programmes were largely non-existent in correctional centres across KZN as perceived by all study participants. This could partly be attributed to the fact that most correctional centres are constructed to maximize public safety, not to efficiently deliver health care.

Furthermore, prison health services often have small budgets. In most Correctional Services facilities, the majority of dental attention is provided on a part-time basis.
under various contractual arrangements. Prison warders who have no health-training act as the first point of consultation, approving and granting permission for inmates to see health workers. This subjectivity could potentially compromise access to health care for some inmates. Some prisoners are assessed as being a threat to the security, safety or order of the prison system and are deemed to be a higher risk than the rest of the prisoner population. As prisons put security as a top priority most staff deployment decisions will be geared towards ensuring that safety is maintained at all times and that could mean that escorting sick inmates receives lower priority. This situation means that some inmates are more likely to be disadvantaged with respect to accessing dental care.

LIMITATIONS OF THE STUDY

Although findings from this study have important practical and political implications, several limitations should be noted. A major limitation of the study was its cross-sectional nature, which limited the ability to relate the time pattern with risk factors such as smoking and their complications on the oral health of the offenders. Since this was self-reporting there could have been over-reporting due to the desire for social acceptance. More research is required to compare the self-reported data to the actual oral health status. The study reflects what is currently in place in KwaZulu-Natal correctional institutions and the findings clearly emphasise that there is an urgent need for the development of a comprehensive oral health preventive programme that will improve the oral health status of this disadvantaged community.

CONCLUSION

The study highlight the need for special attention from the Department of Correctional Services and public oral health sector to meet the basic oral health needs of this population. Preventive oral health care programmes should be planned for offenders in order to educate them with regard to proper oral hygiene practices as eventually many of them will be going back to their communities after serving time.

Therefore, there it is incumbent upon DCS to review its strategy from a curative oral health care to a more preventive approach. Basically, oral health promotion should be an essential part of health service provision in correctional institutions.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Acknowledgments

The authors would like to express their sincere appreciation and gratitude to the Department of Correctional Services for their assistance during this research project and would like to thank all the participants in the study who showed a lot of enthusiasm and cooperation.

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17. Stoller N. Space, place and movement as aspects of health care in three women’s prisons. Social Science and Medicine 2003;56: 2263-76.
Antibiotic prescribing practices of dentists at Medunsa Oral Health Centre

ABSTRACT

Introduction
Inappropriate prescribing and excessive use of broad spectrum antibiotics are reported to be leading contributors to the development of antimicrobial resistance worldwide.

Aims and objectives
To examine the antibiotic prescribing practices of dentists in Medunsa Oral Health Centre.

The range of conditions for which antibiotics were prescribed was identified and the characteristics of antibiotic prescribing were described. The prescription practices were investigated for concurrence with available evidence.

Design
A retrospective, cross-sectional descriptive study in which existing medical records were reviewed.

Methods
Medical records of patients who received medication from the dispensary during March 2017 were reviewed.

Data in the health history questionnaire and data related to demographic characteristics, condition(s) diagnosed, procedure carried out and medication prescribed were extracted.

Information from recent independent reviews and individual studies was reviewed to assess the alignment of prescribing practice with available evidence. References in retrieved review articles were used to identify additional studies.

Results
Healthy patients comprised 74.6% of the study participants. Perioperative prophylactic antibiotics for dental extractions accounted for 59.1% of the prescriptions. Amoxicillin 500mg, three times a day, was prescribed most frequently (74.5%).

Conclusions
Inappropriate prescribing for healthy patients is a common feature of the antibiotic prescribing practice at MOHC.

INTRODUCTION AND BACKGROUND
Inappropriate prescribing and excessive use of broad spectrum antibiotics are reported to be leading contributors to the development of antimicrobial resistance worldwide.

Antibiotics are occasionally prescribed by dentists in dental practice. The rate of antibiotic prescribing by dentists has been reported to range between 7% and 11% worldwide - the rate in South Africa is unknown.

The indications for the use of systemic antibiotics in dentistry are limited since the most common dental infections present in the form of pulpitis and periapical periodontitis and require only operative measures such as fillings, root canal therapy, or extraction if the tooth is not restorable.

Antibiotics are typically prescribed for some of the following purposes: as treatment for acute odontogenic infections; as treatment for non-odontogenic infections; as prophylaxis against focal infection in patients at risk (endocarditis and joint prostheses); and as prophylaxis against local infection and systemic spread in oral surgery.

Reviews of literature on the subject found that antibiotic use in dental practice is characterised by empirical prescription involving the use of a narrow range of broad spectrum antibiotics for short periods of time - typically no more than 7-10 days.
Antibiotic prescription has been found to be almost invariably associated with the prescription of analgesics, particularly non-steroidal anti-inflammatory drugs (NSAIDs). A.

Instances of inappropriate and excessive use of antibiotics in dental practice occur where antibiotics are prescribed for: non-indicated conditions such as dry socket, acute periapical infection and pulpitis; non-clinical factors such as patient’s expectation of an antibiotic prescription, convenience, and demand necessitated by the social background of the patients; and where antibiotics are prescribed to cover either a defect in aseptic clinical technique or improperly sterilized equipment. It has also been reported that some dentists prescribe antibiotics for viral infections like herpes simplex virus-1 infections.

Very little is known about the antibiotic prescribing practices of dentists in South Africa. A 2012 survey, which had an extremely low response rate, investigated their knowledge of treatment guidelines and prescribing practices for antibiotic prophylaxis.

The study found that most dentists were aware of treatment guidelines. However, few actually followed the recommendations for antibiotic prophylaxis, and few correctly prescribed for patients allergic to penicillin. A more recent study has described the antibiotic prescribing patterns of dentists following tooth extraction. The results of this study found that the antibiotic prescribing patterns do not appear to follow a coherent set of guidelines or meaningful indications for antibiotic use.

This study seeks to examine the antibiotic prescribing practices of dentists in Medunsa Oral Health Centre, a dental school and referral hospital in Garankuwa on the outskirts of Pretoria.

OBJECTIVES OF THE STUDY

- To describe the demographic and clinical characteristics of patients who received medication from the dispensary at Medunsa Oral Health Centre during March 2017.
- To describe the characteristics of antibiotic prescribing.
- To identify the range of conditions/procedures for which antibiotics were prescribed and to investigate whether prescription practices were in line with available evidence.

MATERIALS AND METHODS

Study design

This was a retrospective, cross-sectional descriptive study in which existing medical records were reviewed.

Target population

The sampling frame consisted of medical records of 452 patients who received medication from the dispensary at Medunsa Oral Health Centre during March 2017.

Study sample

The ideal sample size was estimated at 159 patient records in Epi Info Version 3.5.4 software at the confidence interval of 95% and absolute precision of 5% assuming an antibiotic prescription rate of 80% among patients who receive medications from the dispensary. However, a sample of only 155 was drawn.

Sampling method

A systematic random sample was selected i.e. a list of the entire population using patient names was prepared in Excel; the sample size of 159 was divided into the total population (452) to calculate the Kth number. The Kth number was 3. A random starting point was selected (a number between 1 and 3), we selected 3. We started with the third person and picked every third person on the list.

MEASUREMENTS

Data collection

Medical records of patients who received medication from the dispensary during March 2017 were reviewed. Data in the health history questionnaire and data related to demographic characteristics, condition(s) diagnosed, procedure carried out and medication prescribed were extracted.

Information from recent independent reviews and individual studies was reviewed to assess the alignment of prescribing practice with available evidence. References in retrieved review articles were used to identify additional studies.

Definition of variables and terms

Age and Gender refer to patient age and sex as recorded in medical records.

Ethical considerations

Ethical approval for the study was granted by the Ethics Committee of the Sefako Makgatho Health Sciences University. Permission to conduct the study was granted by the Chief Executive Officer (CEO) of Medunsa Oral Health Centre.

STATISTICAL ANALYSIS

Data was captured, coded and cleaned in Microsoft excel software and then transferred to Statistical Analysis Software (SAS) software for analysis. Means, frequencies and proportions (percentages) were calculated.

RESULTS

Data of a systematic random sample of 142 records was analysed. A response rate of 89.3% was achieved.

The age group 18-34 years comprised a little less than sixty percent (58.5%) of the study participants. Females constituted 52.1%.
Table 1: Demographic characteristics

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Female n (%)</th>
<th>Male n (%)</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-17 years</td>
<td>7 (4.9)</td>
<td>5 (3.5)</td>
<td>12 (8.5)</td>
</tr>
<tr>
<td>18-34 years</td>
<td>43 (30.3)</td>
<td>39 (27.5)</td>
<td>82 (58.5)</td>
</tr>
<tr>
<td>35-51 years</td>
<td>13 (9.2)</td>
<td>17 (12.0)</td>
<td>30 (21.1)</td>
</tr>
<tr>
<td>52-68 years</td>
<td>8 (5.6)</td>
<td>5 (3.5)</td>
<td>13 (9.2)</td>
</tr>
<tr>
<td>69+ years</td>
<td>3 (2.1)</td>
<td>1 (0.7)</td>
<td>4 (2.8)</td>
</tr>
<tr>
<td>Total</td>
<td>74 (52.1)</td>
<td>67 (47.2)</td>
<td>142 (100)</td>
</tr>
</tbody>
</table>

Antibiotics were prescribed for 65.5% of the study participants. Patients with no history of systemic illness comprised a little less than three-quarters (74.6%) of the study participants - three out of five (64/106) were prescribed antibiotics.

HIV infected patients constituted the second largest category (6.3%) of study participants - both patients were prescribed antibiotics.

Table 2: Clinical characteristics

<table>
<thead>
<tr>
<th>History of systemic illness</th>
<th>Antibiotic prescribed</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Yes n (%)</td>
<td>No n (%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2 (1.4)</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>6 (4.2)</td>
<td>2 (1.4)</td>
</tr>
<tr>
<td>Heart condition</td>
<td>2 (1.4)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>HIV</td>
<td>9 (6.3)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Allergy</td>
<td>3 (2.1)</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Flu</td>
<td>1 (0.7)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Localized illness</td>
<td>6 (4.2)</td>
<td>3 (2.1)</td>
</tr>
<tr>
<td>Total</td>
<td>93 (65.5)</td>
<td>43 (30.3)</td>
</tr>
</tbody>
</table>

Table 3: Number of antibiotics per prescription

<table>
<thead>
<tr>
<th>Antibiotics</th>
<th>Prescriptions n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>77 (82.8)</td>
</tr>
<tr>
<td>2</td>
<td>16 (17.2)</td>
</tr>
<tr>
<td>Total</td>
<td>93 (100)</td>
</tr>
</tbody>
</table>

Table 4: Frequency of prescription by antibiotic dosage

<table>
<thead>
<tr>
<th>Types of antibiotics</th>
<th>125 mg</th>
<th>200mg</th>
<th>250mg</th>
<th>400mg</th>
<th>500mg</th>
<th>625mg</th>
<th>1gram</th>
<th>2gram</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t.d.s.</td>
<td>t.d.s.</td>
<td>t.d.s.</td>
<td>t.d.s.</td>
<td>t.d.s.</td>
<td>t.d.s.</td>
<td>t.d.s.</td>
<td>t.d.s.</td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>3</td>
<td>N/A</td>
<td>5</td>
<td>N/A</td>
<td>82</td>
<td>N/A</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>N/A</td>
<td>3</td>
<td>N/A</td>
<td>14</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>17</td>
</tr>
<tr>
<td>Augmentin</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>14</td>
<td>82</td>
<td>1</td>
<td>1</td>
<td>110</td>
</tr>
</tbody>
</table>

N/A: not available

Table 5: Duration of antibiotic prescription

<table>
<thead>
<tr>
<th>Days</th>
<th>Patient n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day</td>
<td>2 (2.2)</td>
</tr>
<tr>
<td>5 days</td>
<td>83 (89.2)</td>
</tr>
<tr>
<td>7 days</td>
<td>8 (8.6)</td>
</tr>
<tr>
<td>Total</td>
<td>93 (100)</td>
</tr>
</tbody>
</table>

Antibiotics were prescribed for a wide selection of conditions

Table 6: Condition/procedure-specific antibiotics prescribing

<table>
<thead>
<tr>
<th>Conditions/procedures</th>
<th>Antibiotics</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes n (%)</td>
<td>No n (%)</td>
</tr>
<tr>
<td>Infective endocarditis</td>
<td>2 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Dry socket</td>
<td>3 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Emergency/Elective</td>
<td>4 (80)</td>
<td>1 (20)</td>
</tr>
<tr>
<td>root canal therapy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Periodontal diseases</td>
<td>6 (66.7)</td>
<td>3 (33.3)</td>
</tr>
<tr>
<td>Routine/surgical</td>
<td>55 (78.6)</td>
<td>15 (21.4)</td>
</tr>
<tr>
<td>extractions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pericoronitis</td>
<td>3 (75)</td>
<td>1 (25)</td>
</tr>
<tr>
<td>Biopsy</td>
<td>2 (50)</td>
<td>2 (50)</td>
</tr>
<tr>
<td>No diagnosis</td>
<td>5 (55.6)</td>
<td>4 (44.4)</td>
</tr>
<tr>
<td>Painful tooth</td>
<td>3 (75)</td>
<td>1 (25)</td>
</tr>
<tr>
<td>Other conditions</td>
<td>10* (31.2)</td>
<td>22 (68.8)</td>
</tr>
<tr>
<td>Total</td>
<td>93 (65.5)</td>
<td>49 (34.5)</td>
</tr>
</tbody>
</table>

*Antibiotics were prescribed for a wide selection of conditions

Antibiotics were prescribed for a little less than two-thirds (65.5%) of the study participants. Perioperative prophylactic antibiotics for dental extractions accounted for 59.1% (55/93) of the prescriptions.

Healthy patients comprised a little less than two-thirds (65.5%) of the recipients of perioperative prophylaxis.

HIV infected patients comprised the second highest category (10.9%) of perioperative prophylaxis recipients.

Routine extractions accounted for 54.5% of perioperative prophylactic antibiotics prescriptions.
DISCUSSION

This study set out to describe the antibiotic prescribing practices of dentists at Medunsa Oral Health Centre. The alignment of the prescribing practices to current evidence was also described.

Demographic characteristics

The results of this study show that the age group 18-34 years comprised a little less than sixty percent of the study participants. This finding does not support the previous research of Marra and colleagues (2016) who found that the rate of antibiotic prescribing increased the most for dental patients 60 years or older in British Columbia, Canada.4

The population pyramid of South Africa, which is typical of a developing country, might explain this contradiction.

Females constituted 52.1% of the study participants, which seem to be consistent with those of other studies which found that more women than men were prescribed antibiotics at dental clinics.14

Clinical characteristics

The current study found that patients with no history of systemic illness comprised a little less than three-quarters (74.7%) of study participants. This result seems to be consistent with other research which found that the majority of dental patients are healthy.12,15

HIV infected patients constituted the second largest category (6.3%) of study participants. The findings of the current study are consistent with those of Ogbebor and colleagues (2015) who found that the prevalence of HIV among dental patients in Nigeria was below the national average16 - South Africa’s national average is 12.6%.17

The HIV prevalence data obtained in the current study cannot be extrapolated to all patients who visited MOHC during March and therefore need to be interpreted with caution.

Less than two percent (1.4%) of the study subjects had a history of heart condition(s). This finding was unexpected considering that the incidence of symptomatic rheumatic heart disease in adults and the prevalence of asymptomatic rheumatic heart disease in schoolchildren are high. Rheumatic heart disease is the major predisposing factor of infective endocarditis in young adults.14 It is difficult to explain this result.

Characteristics of antibiotic prescribing

The results of this study indicate that antibiotics were prescribed for 65.5% of the study participants. This result has not previously been described.

Unfortunately, the prevalence of antibiotic prescribing at MOHC during March could not be established due to inaccurate patient data.

There was no clear separation of data of patients on the hospital appointment system from that of patients not on the hospital appointment system, who were referred for general dental care and/or for initial assessment in the relevant specialty clinics. This is an important issue for future research.

The current study found that four out of five patients were prescribed a single antibiotic; amoxicillin 500mg, three times a day, was prescribed most frequently (82/94), and that a five-day supply of antibiotics was prescribed for nine out of ten patients. This study produced results which corroborate the findings of a great deal of the previous work in this field.4,6,12

The most interesting finding was that three out of five (64/106) patients with no history of systemic illness were prescribed antibiotics.

Considering that the indications for the use of systemic antibiotics in dentistry are limited, the high frequency of antibiotic prescribing observed in the current study is inappropriate.

Another important finding was that a little more than half (36/64) of patients with no history of systemic illness were prescribed antibiotics for extractions - an equal number (18) for routine and surgical extractions respectively.

Although, these results differ from those of Laloo and colleagues (2016), they are consistent with those of Akinbami and Osagbemiro (2015) who found that 55% of healthy patients who underwent routine extractions were prescribed antibiotics.12,15

The present finding seems to be consistent with other research which found that dentists were more likely to prescribe antibiotics for individuals undergoing extraction of impacted teeth.12

Table 7: Perioperative prophylactic antibiotics

<table>
<thead>
<tr>
<th>History of systemic illness</th>
<th>Antibiotics</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Routine extractions n (%)</td>
<td>Surgical extractions n (%)</td>
</tr>
<tr>
<td>None</td>
<td>18 (50)</td>
<td>18 (50)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Heart condition</td>
<td>2 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>HIV</td>
<td>5 (83.3)</td>
<td>1 (16.7)</td>
</tr>
<tr>
<td>Allergy</td>
<td>0 (0)</td>
<td>1 (100)</td>
</tr>
<tr>
<td>Localized illness - Back operation/ Psychosomatic disturbance/ Tonsillitis</td>
<td>3 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Missing history of illness data</td>
<td>1 (20)</td>
<td>4 (80)</td>
</tr>
<tr>
<td>Total</td>
<td>30 (54.5)</td>
<td>25 (45.5)</td>
</tr>
</tbody>
</table>
The results of this study show that all HIV infected patients who received medication from the dispensary were prescribed antibiotics – two-thirds (6/9) of the prescriptions were for extractions. This finding was unexpected. Further research should be done to investigate the indications for antibiotic prescribing in HIV infected dental patients.

**Range of conditions/procedures for which antibiotics were prescribed**

The prevalence of antibiotic prescribing for conditions other than extractions has not previously been described.

**Infective endocarditis prophylaxis**

The results of this study show that antibiotics dispensed to prevent infective endocarditis constituted 2.2% of the antibiotic prescriptions filled. Antibiotic prophylaxis to prevent infective endocarditis is widely accepted by the dental profession. The effectiveness of such antibiotic prophylaxis in humans, however, remains unproven.

The more recent Cochrane review in 2013 concluded that there remains no evidence about whether antibiotic prophylaxis is effective or ineffective against bacterial endocarditis in people at risk who are about to undergo an invasive dental procedure. However, the prophylaxis guidelines recommended by AHA, ESC and BSAC are applied in South Africa. The current study found that the regime recommended for patients not hypersensitive to penicillin was ordered. 21

**Dry socket**

The current study found that antibiotics dispensed for the treatment of dry socket constituted 3.2% of the antibiotic prescriptions filled. The range of treatments for a dry socket includes non-dressing and dressing interventions directed locally to the socket and, where appropriate, the prescription of systemic antibiotics.

The level of evidence for effectiveness of most management guidelines was found to be low. They were found to be based on expert opinions and clinical experience. A recent Cochrane review in 2012 concluded that there was insufficient evidence to determine the effects of any of the local interventions to treat dry socket.

It is however widely accepted that systemic antibiotics should not be prescribed for the treatment of dry socket as they have no additional advantage over local treatments directed to the socket in a non-immune-compromised patient, due to the potential for development of resistant strains to the antibiotics and other side effects such as hypersensitivity.

The results of this study indicate that two thirds of the cases of dry socket prescribed antibiotics had concomitant illnesses or immunodeficiency - flu and diabetes. Both conditions are indicated for antibiotic therapy according to current evidence.

Another important finding was that antibiotics were prescribed for a healthy case of dry socket, which is contrary to current evidence.

**Endodontics**

The results of this study indicate that antibiotics dispensed for elective or emergency root canal therapy constituted 4.3% of antibiotics prescribed. In endodontics, antibiotics are unnecessary in irreversible pulpitis, necrotic pulps and localised acute apical abscesses.

The lack of blood circulation in the root canal in these conditions prevents antibiotics reaching the area. Antibiotics are however indicated as an adjunct during endodontic therapy in acute apical abscess in medically compromised patients, acute apical abscess with systemic involvement, progressive infections and persistent infections, as they assist in the prevention of the spread of infection.

The diagnoses of different pulp diseases were not recorded in this study. This made it difficult to determine the extent that practice deviates from current evidence.

**Periodontics**

The results of this study indicate that antibiotics dispensed to treat periodontal diseases constituted 6.5% of prescribed antibiotics. Chronic inflammatory periodontal conditions are not indicated for antibiotics; systemic antimicrobials should only be used in acute periodontal conditions where drainage or debridement is impossible, where there is local spread of the infection or where systemic upset has occurred.

Clinical trials have produced evidence of additional benefits when metronidazole alone or with amoxicillin in various doses and durations are used as adjuncts to scaling and root planing for the treatment of chronic periodontal disease. Clear guidelines for the use of these agents in the clinical practice are not yet available.

The low rate of antibiotic prescribing in the current study supports previous research in the field of systemic antibiotics in the treatment of periodontitis.

**Extractions**

Perioperative prophylaxis for dental extractions accounted for 59.1% (55/93) of the antibiotics prescriptions.

**Routine dental extractions**

The results of recent clinical trials show that there is no significant difference in the incidence of post extraction complications in healthy patients undergoing routine dental extractions prescribed perioperative prophylactic antibiotics and those not prescribed antibiotics. However, patients at higher risk of infection are more likely to benefit from...
prophylactic antibiotics. Akinbami and Osagbemi (2015) found that the type of extraction, difficulty of extraction and adherence to postoperative instructions were important associated factors that determined the occurrence of postoperative complications.

Surgical extraction of lower third molars

The issue of prophylactic antibiotic therapy in third molar surgery in healthy patients is highly controversial. Conflicting results have been reported. However a meta-analysis of 16 clinical trials with a total of 2,932 participants published in 2007 concluded that systemic antibiotics given before the surgery were effective in reducing the frequencies of dry socket and wound infection after third molar surgery.

A more recent Cochrane review in 2013 of 18 double-blind placebo-controlled trials with a total of 2456 participants concluded that there is evidence that prophylactic antibiotics reduce the risk of infection, dry socket and pain following third molar extraction and result in an increase in mild and transient adverse effects.

The review further concluded that patients at higher risk of infection, the risk may be up to 25% in patients who are already sick or have low immunity, are more likely to benefit from prophylactic antibiotics, because infections in this group are likely to be more frequent, associated with complications and be more difficult to treat. A more recent prospective cohort study corroborates these reviews.

Pericoronitis

The results of this study indicate that 3.2% of antibiotics were dispensed to treat pericoronitis. Adjunctive antimicrobial therapy is recommended to treat acute pericoronitis if there are systemic signs and symptoms.

Intra-oral soft tissue biopsy

Antibiotic prophylaxis to prevent infective endocarditis should be given in advance of biopsies.

Patients at increased risk for postoperative wound infection should be placed on oral antibiotic therapy following the surgical procedure. The results of the current study are in agreement with accepted practice.

No diagnosis

The results of this study indicate that 5.4% of antibiotics were dispensed in the absence of a diagnosis. This unanticipated finding has not previously been described.

Painful tooth

The current study found that antibiotics dispensed for the treatment of the non-specific symptom of painful tooth constituted 3.2% of the antibiotic prescriptions filled. This finding was unexpected and unfortunate. Conditions such as acute perialpal infection and pulpitis are not indicated for antibiotic treatment.

Limitations of the study

The prevalence of antibiotic prescribing at MOHC during March could not be determined due to inaccurate data.

The potential threats to the internal validity of the study were those arising from non-response bias – a response rate of 89.3% was achieved, and incomplete records.

CONCLUSION

Inappropriate prescribing for healthy patients is a common feature of the antibiotic prescribing practice at MOHC.

References

should not be underestimated, it is a career-long obligation for practicing professionals. The objective of CPD, to assure continuing education. The importance of continuing professional development

Do the CPD questionnaire on page 536

The Continuous Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

Online CPD in 6 Easy Steps

1. Go to the SADA website www.sada.co.za.
2. Log into the 'member only' section with your unique SADA username and password.
3. Select the CPD navigation tab.
4. Select the questionnaire that you wish to complete.
5. Enter your multiple choice answers. Please note that you have two attempts to obtain at least 70%.
6. View and print your CPD certificate.
A four-year-old female presented with the main complaint of limited opening of the mouth (Fig.1). She appears to have some form of discomfort when eating her food and according to her mother, this problem started shortly after birth and has not received any form of treatment. What is your diagnosis?

The pantomograph (Fig.2) shows irregular radiopacity representing an extra-articular ankylosis of the temporomandibular joint region and lack of joint space on the right side (green arrow). A diagnosis of osseous ankylosis of the TMJ was made, which is the bony union of the mandibular condyle with part of the temporal bone, resulting in immobility of the joint. Ankylosis of the TMJ is one of the most incapacitating of all diseases involving this structure. The most frequent causes of ankylosis of the TMJ are traumatic injuries and infections in and about the joint. Infections commonly result in inflammatory destruction of the synovial lining of the joint, resulting in contact between the underlying osseous structures. The inflammation may result from primary infection of the joint; extension from a neighbouring infection such as otitis media, mastoiditis, or osteomyelitis of the mandible; blood-borne infections from several sources; trauma to the joint; or one of the rheumatoid arthritis, ankylosing spondylitis; psoriatic arthritis and Reiter syndrome. True ankyloses between the condyle and temporal bone manifest as a painless inability to open the mouth properly. The degree of inability is variable, because the bone of the mandible is somewhat flexible; thus even with bilateral ankyloses there is not complete lack of movement of bone. In unilateral cases there is usually a fullness of the face on the affected side (Fig.1 yellow arrow), and flattening of the face on the unaffected side (Fig.1 red arrow). Deviation of the midline toward the affected side may also be present, a result of unilateral growth. If the ankylosis is bilateral (Fig.3) and has been present before the end of somatic growth, retrognathia and downward growth of the mandible may be present. A 3-D reformatted CT scan (Fig.4) shows a mass of bone extending laterally from the ramus, joining the condyle to the borders of the glenoid fossa (blue arrow). This is pathognomic of bilateral osseous ankylosis of the TMJ. Treatment of osseous ankylosis consists of osteotomy and removal of a section of bone below the condyle. Fibrous ankylosis may be treated by functional methods.

References:
1. Diamond burs versus curettes in root planing: a randomized clinical trial.


Gracey curettes are the most widely used instruments for root planing and are regarded as the gold standard, but their usage is technique sensitive and time consuming for the clinician and efficacy is reduced in deep pockets, root irregularities, and furcations. Alternative sonic, ultrasonic and rotary instruments have been investigated for potential benefits in improving mechanical access. Sonic and ultrasonic instruments are used for scaling, but these cannot provide smooth root surfaces.

Intensiv Perio Set is a rotating diamond bur system developed for odontoplasty, scaling and root planing. It is used only in right angle hand piece, at rotation speeds of 6000 rpm, with reduced pressure application. These burs have two different head types for morphologically different areas; flame or tapered, three different grains; 75, 40, or 15 μm, with either a short or long neck for each unit. Burs with 75 μm grain are used only in odontoplasty, whereas, 40 and 15 μm burs are used for scaling and root planing.

There is no clinical study in humans evaluating microbiological, biochemical and scanning electron microscopic (SEM) findings of non-surgical periodontal therapy with diamond burs. Different techniques and instrumentation used for SRP may lead to differences in surface properties that may affect treatment outcome by creating retention loci for bacteria.

Tactile perception by the clinician may not be precise enough to determine the smoothness of a root surface. Therefore, in vitro evaluation techniques are frequently used in studies comparing root surface topography following SRP with various instruments. It is hypothesized that RP with diamond burs provide comparable findings with curettes in pockets with probing depth (PD) of 5 mm more in a shorter time.

Türkтекин and colleagues (2018) reported on a randomized clinical trial that sought to compare diamond burs and curettes in non-surgical periodontal treatment of chronic periodontitis patients.

METHODS

Fifteen patients were recruited for this single-centred, randomized, prospective, split-mouth, controlled clinical trial. Inclusion criteria were: clinical diagnosis of generalized chronic periodontitis; presence of at least three teeth with PD of 5 mm or more and clinical attachment level (CAL) of 4 mm or more in each quadrant. Exclusion criteria were: presence of any known systemic disease or using medications that affect periodontal tissues; antibiotic treatment and/or periodontal treatment within the past six months; tobacco use during the last 12 months; and being pregnant or in the lactation period. Third molars, maxillary first premolars (due to their frequently having two roots and root concavities), crown/bridge abutment teeth and teeth...
with enamel projections or pearls, or excessive destruction of crown were excluded. Plaque index (PI), papilla bleeding index (PBI), PD and CAL were measured by a single calibrated researcher at six sites/tooth, at baseline and 1, 3 and 6 months after completion of SRP.

Gingival crevicular fluid (GCF) and subgingival plaque sampling were obtained from the deepest site in each quadrant at baseline and then one month after completion of SRP. Sampling sites were air-dried gently, isolated with cotton rolls and supragingival plaque was gently removed with sterile curettes. GCF samples were collected by inserting filter paper strips (Periopaper; Oraflow, Plainview, NY, USA) one mm into the pocket and leaving for 30 s.

The absorbed GCF volume was estimated by a calibrated instrument (Periotron 8000). Subgingival plaque samples were obtained from the same sites by sterile paper points from the base of the pockets. Samples were placed separately in polypropylene tubes, frozen immediately and kept at -40 °C until the laboratory analyses. Patients were motivated and instructed to brush with modified Bass technique and use interdental toothbrushes and dental floss. A strict protocol was followed and the RP was completed during a single session. In brief, RP was performed under local anaesthesia. Diamond burs (Intensiv Perio Set) were used in the test quadrants and curettes were used in the control quadrants. Randomization was performed with a computer-generated list.

In the test quadrants, 15- and 40-μm burs with long necks were used at 6000 rpm with low pressure. Tapered burs were used particularly at the anterior teeth to reach narrow subgingival sites, whereas flame burs were used at premolars and molars to reach the furcation sites and root concavities. A new bur set and a standard curette set newly sharpened with Arkansas stone were used for each patient. A single researcher performed SRP in all patients. The procedures were continued until a hard, smooth root surface was sensed with an explorer tip. The time spent for RP was recorded for both treatment types.

The samples collected at baseline and one month following SRP were subjected to polymerase chain reaction (PCR) assay standards and selected bacterial type strains were grown on agar plates prepared with the appropriate culture media and atmospheric conditions. Enzyme-linked immunosorbent assay and specific kits were used for measurement of interleukin (IL)-1β, tumour necrosis factor-α (TNF-α), osteoprotegerin (OPG), human soluble receptor activator of nuclear factor-κB ligand (sRANKL) (Peprotech, London, UK) levels according to the manufacturers’ recommendations in 96-well plates in duplicate. Colour development was measured at 450 nm with wavelength correction set at 650 nm using a microplate reader (FLUOstar Omega). The minimum detection limits were as follows: TNF-α, 1.6 pg/mL; IL-1β, 1.6 pg/mL; OPG, 8.4 pg/mL; and sRANKL, 3.9 pg/mL.

Twenty-one hopeless teeth (three single-rooted, 18 multi-rooted) destined for extraction were randomly divided into three groups with seven teeth in each group: RP with diamond burs; RP with curettes; no treatment. A notch was made at the level of gingival margin before extraction for localization of the surface that would be examined.

Extracted teeth were rinsed with saline for 2 min. The roots were separated from the crowns and rinsed with saline, stored in 2.5% glutaraldehyde for 30–60 min, transferred to ethanol for dehydration in an ascending ethanol series (25%, 50%, 75% and 90%) and held in 100% ethanol overnight. Dehydrated samples were bonded to the bell metal, stored in a desiccator for 6 days, coated with 200 Å gold (Polar on C502).

Microphotographs were taken at the SEM Laboratory. In total, 180 photos were taken at ×350 magnification. A number was assigned to each photograph before blinding the treatment to the examiner. All photographs were divided into nine equal regions by a standard grid and evaluated separately at full-screen resolution. The microphotographs were graded on a VAS scale ranging 1–10 to harmonize measurement criteria. ‘0’ was the surface without calculus, no loss of tooth substance and devoid of instrumental marks, while ‘10’ denoted the maximum observed contrary score.

RESULTS

This six-month follow-up study was completed with 12 patients (seven men, five women, aged 37-60 years; mean age, 46.41 ± 6.22) of the original 15 patients recruited; three patients had to be excluded due to non-compliance. The average duration of an RP session was 41.6 min for the burs and 36.5 min for the curettes (P < 0.05). In total, 371 sites from single-rooted (burs, 185; curettes, 186) and 239 sites from multi-rooted (burs, 122; curettes, 117) teeth were evaluated. The distribution of various teeth was similar for the two treatment modalities (P > 0.05).

There was no significant difference in full-mouth clinical periodontal findings at any time point of the study between teeth treated with burs and those treated with curettes (P > 0.05). The improvements in clinical periodontal findings were also similar with both treatment modalities. PD and CAL reductions from the baseline values were significant at single- or multi-rooted teeth with curettes and burs (P < 0.0001). The reductions in PD were seen to be significantly greater at single-rooted teeth than at multi-rooted teeth at 1, 3 and 6 months when burs were used for RP (P < 0.05) and at 3 and 6 months when the curettes were used for RP (P < 0.05). Clinical improvements in PD, CAL, PI and PBI were evident at 1 month at the selected GCF and microbial sample sites (P < 0.05) and these improvements were similar for burs and curettes (P > 0.05).

Bacteria numbers revealed similar findings at the two treatment sites at baseline and 1-month evaluation (P > 0.05). The percentages of F. nucleatum and T. denticola were reduced at curette-treated sites, while percentages of P. gingivalis and Peptostreptococcus micros were reduced at bur-treated sites of single-rooted teeth significantly at 1-month follow up when compared with the baseline values (P < 0.05). Gingival crevicular fluid sample volumes were similar in the two RP modalities both at baseline and 1 month after treatment. Total amount of IL-1β and TNF-α changed similarly following treatment. The cytokine levels were similar for the two RP modalities at baseline (P > 0.05). At 1 month, significant differences were found in the total amounts of IL-1β and TNF-α between the GCF samples.
RP with burs revealed better results in the mandibular and maxillary furcations, whereas RP with curettes indicated better findings in the mandibular molar approximal root surfaces ($P < 0.0001$). Curettes appeared to be more successful in SRI than the burs in single-rooted teeth and mandibular furcations without significant differences ($P > 0.05$). The burs were significantly better at maxillary furcational root sites ($P < 0.0001$) and curettes were better at molar approximal root surfaces ($P < 0.0001$).

RCI and LTSI up to dentin and instrumental marks revealed no significant differences between the two treatment modalities ($P > 0.05$). Both treatment types showed improvements when compared with untreated sites on all surfaces except for the furcations but the differences were significant only for the furcational root surfaces of bur-treated mandibular molars ($P < 0.0001$).

**CONCLUSION**

Within the limits of the present study, it can be concluded that RP with diamond burs provided similar clinical, microbiological and biochemical data when compared with curettes.

**Implications for practice**

The use of diamond burs appears to be a suitable alternative to curettes for RP in patients with chronic periodontitis.

**Reference**


2. Effect of intracanal cryotherapy on pain after single-visit root canal treatment.


Prevention and management of postendodontic pain is an integral part of endodontic treatment. Informing patients about expected postendodontic pain and prescribing medications to manage it can increase patient confidence in their dentist, increase patients’ pain threshold, and improve their attitude toward future dental treatment.

It is generally accepted that there are various factors affecting postoperative pain including the condition of pulp and periradicular tissues, preoperative pain, and the presence of periapical radiolucency. The causes of postoperative pain can be classified as mechanical, chemical and/or microbiological injuries to the periradicular tissues. These periapicals injuries often lead to periapical inflammation known as flare-ups.¹

Several strategies have been developed for postoperative pain management including prescribing prophylactic analgesics and corticosteroids, administering long-lasting anaesthesia, root canal preparation using the crown-down technique and occlusal reduction.¹

Cryotherapy is a long-standing technique that has been frequently applied in sports injuries and surgical procedures for pain management and postoperative care.¹

Cryotherapy has been reported to be effective at decreasing oedema, pain, inflammation and recovery time with short-term applications in orthopaedic, abdominal, gynaecological and hernia operations. Consequently, the local physiological effects and mechanisms of action of cryotherapy were investigated. The application of cold basically subtracts heat from tissues and results in a decreased temperature. When the temperature decreases, vasoconstriction occurs and restricts oedema formation. Vasoconstriction also decreases cell metabolism, thereby reducing the oxygen demand of cells and limiting the production of free radicals in tissues. Inflammatory enzymes have also been reported to increase with rising temperature.¹

A local cold application onto the skin has been shown to alter pain threshold and reduce pain. Cryotherapy also affects the conduction capacity of nerves. Nociceptors are specialised nerve endings that are activated when tissue injury occurs. There are also pain receptors called thermoreceptors, which are temperature-sensitive nerve endings that are activated by changes in tissue temperature.¹ Activation of these thermoreceptors by cryotherapy can block nociception within the spinal cord.¹

In dentistry, cold application has been frequently utilised following intraoral surgical procedures for postoperative pain control. It has also been speculated that cryotherapy has the potential to result in a local anti-inflammatory effect in periradicular tissues.

However, no literature exists as to whether cryotherapy reduces postoperative pain or not. Keskin and colleagues (2017)¹ reported on a trial that sought to evaluate the effect of cold saline irrigation as a final irrigant following biomechanical preparation of root canals on postoperative pain in patients with irreversible pulpitis.

**METHODS**

A total of 170 patients aged between 19 and 63 years were included in this randomised clinical trial. Patients with one maxillary or mandibular tooth diagnosed
Coronal access cavities were restored with direct using gutta-percha cones and AH Plus (Dentsply Maillefer) and obturated with cold lateral compaction technique. In both groups, the root canals were dried with paper points.

In both groups, the root canals were dried with paper points. Random division of participants into a cryotherapy group (n = 85) and a control group (n = 85) occurred after informed consent but prior to the initiation of treatment. Each patient was assigned a number and asked to choose a sealed envelope, which contained a piece of paper with a group name written on it. According to the text written on the piece of paper, the patients were randomly assigned to either the cryotherapy or the control group. Both groups received pre-established procedures.

Prior to treatment the patients were instructed how to complete a visual analogue scale (VAS) to determine their pain scores. The VAS included a 10 cm straight horizontal line numbered at each centimetre with following criteria: 0, no pain; 1–3, mild pain; 4–6, moderate pain; 7–9, severe pain and 10, the worst pain experienced. After recording preoperative pain levels, local anaesthesia with 4% articaine containing 1:100 000 epinephrine was administered, a rubber dam was applied and the endodontic access cavities were prepared with sterile burs.

None of the patients required further anaesthetic use. Following removal of the pulp tissue with broach, a glide path was established with a #10 K file. The working lengths (WL) were determined using a Root ZX mini apex locator and confirmed radiographically. The root canals were instrumented with a ProTaper Next (Dentsply) system under copious irrigation with 5.25% sodium hypochlorite (NaOCl) at a rate of 3 mL min⁻¹. The files were driven by an endodontic motor and used with a continuous brushing motion according to the manufacturer’s instructions.

Patency was confirmed with a #10 K file between each instrument change. The root canals were flushed with 5 mL of 17% EDTA solution agitated with EndoActivator (Dentsply) for 1 min and 5.25% NaOCl. In cryotherapy group, following completion of biomechanical preparation, the root canals were irrigated with at a temperature of 2.5°C; the solution was stored in refrigerator until use. In the control group, final irrigation was performed for 5 min in the root canals of each tooth using a 31 G NaviTip needle inserted 2 mm short of the WL (Ultradent Products).

Due to the use of cold or warm syringes during root canal treatment, blinding of the endodontists was not possible. The final irrigation was performed for 5 min in the root canals of each tooth using a 31 G NaviTip needle inserted 2 mm short of the WL (Ultradent Products).

In both groups, the root canals were dried with paper points and obturated with cold lateral compaction technique using gutta-percha cones and AH Plus (Dentsply Maillefer). Coronal access cavities were restored with direct composite restorations using dentinal adhesives (Single Bond Universal) and universal composite resin (Charisma). Patients were instructed to complete VAS to determine their postoperative pain scores at 24 and 48 h. Patients were told to use analgesics if they experienced severe pain that required analgesics and to contact their dentists for any type of emergency related to treated teeth. Patients were contacted by telephone by one of the endodontists and asked whether they experienced any pain or use analgesics and, if so, their VAS scores were recorded.

Patients in the cryotherapy group reported significantly lower VAS scores compared with patients in the control group (P < 0.05) at 24 h follow-ups. In the cryotherapy group, 85.88% of patients had no postoperative pain, 12.94% of patients reported mild pain, and 1.18% of patients reported moderate pain; in the control group, 68.23% of patients had no postoperative pain, 24.71% of patients reported mild pain, and 7.06% of patients reported moderate pain at 24 h.

At the 48 h follow-up pain scores revealed a significant reduction; only one patient from the cryotherapy group (1.17%) and two patients from the control group (2.35%) reported mild pain. None of the patients reported severe pain or flare-ups during the period of the study. There was no significant difference between gender and the postoperative pain in either group (P > 0.05). There was also no significant difference between the tooth type and the postoperative pain in either group (P > 0.05).

CONCLUSION
Cryotherapy reduced postoperative pain following single-visit root canal treatment in teeth with vital pulps. Over a 24 hour period, patients in the cryotherapy group reported significantly lower postoperative pain than patients in the control group.

Implications for practice: This trial provides evidence for the use of cryotherapy as a simple, cost-effective, and non-toxic option for postoperative pain control in single visit root canal treatment. Significant postoperative pain relief is obtained within 24 hours as compared to the use of 0.9% physiological saline solution at the room temperature.

Reference
“It is only with the heart that one can see rightly. What is essential is invisible to the eye”
(The Little Prince, by Antoine De Saint-Exupery).

Children with inherited dental anomalies have many complex problems that may interfere with their physical, mental and psychological well-being. The anomalies generally present early in life as isolated conditions, or associated with other defects, and may require immediate as well as prolonged multidisciplinary management.

The spectrum of defects is diverse, as is the range of deformities that can manifest in the head and neck region. Common to all is their potential to have profound negative consequences for the individual and their families, ranging from aesthetic concerns that impact on their self-esteem, to masticatory difficulties, tooth sensitivity, financial burdens, and protracted dental treatment.

There is a great emphasis on the face as the most valued aspect of human beauty, as it is the one feature which cannot be concealed, and is often used by others to describe a person.

People instinctively and preferentially look at the faces in photographs, and studies have even found that viewing attractive faces activates brain structures associated with the reward centres in the brain such as those related to food and money. These perceptions are so embedded in society that facial attractiveness has even been defined as “a social necessity” or “a gift from God”.

Beauty also has positive reinforcement values such that those who possess this “gift” are also perceived to have other positive personality traits and seem to be liked more, and to benefit from preferential treatment in all aspects of life, and throughout their lives.

Many believe that beauty is the bearer of identity, character and intelligence, and that being beautiful affords both men and women advantages in school, and in their chosen careers. Attractive employees often receive more promotions and salary raises than their less attractive counterparts, good-looking students are more popular, are considered to be more intelligent and often do better in school.

Some have gone so far as to state that “there is a universal standard for facial beauty based on ideal proportions that are directly related to the divine proportion. Organisms that conform to these proportions are not only beautiful, but also biologically healthy”. Others believe that facial symmetry is an important determinant of good looks, and that body symmetry is directly related to mental ability, despite the fact that mild asymmetry is normal.

These unrealistic notions and pursuit of perfection have become an obsession and a multi-million rand industry with many individuals resorting to extreme measures in the attempt to attain the perfect look.
On the other hand, reverse stereotypes about less attractive individuals also exist. Those with abnormal facial features are often discriminated against, and considered to be dishonest, less capable, less intelligent, aggressive and less successful based on unsubstantiated assumptions.³

At the same time, a person’s own perception of their facial appearance is of great importance, and thus it is not surprising that patients with craniofacial defects may experience difficulties adapting to their deformity, no matter how mild or severe. This erroneous appraisal can interfere with their personal lives, having a negative psychosocial impact, with increased self-consciousness, low self-esteem, behavioural disorders, poor social interactions, and emotional distress.¹⁴

**PARENTAL PRESSURE TO TREAT**

Considering that the “face is often the foundation of judgement when assessing appearance”,³ any facial deformity may be considered a “social disability” that impacts on the individual, as well as their families, who observe how it is noticed and reacted to by strangers.⁴

Children with a different dentofacial appearance are often subject to unsympathetic teasing, harassment, and malicious verbal and physical intimidation.³ The impact of this may be seen by the child developing habits and behaviour to try to conceal the mouth, such as covering with their hands, tensing their oral musculature, avoiding smiling, avoiding eye contact, limiting speaking and communicating with others, social embarrassment and a negative body image.¹⁰

It is thus not surprising that parents who wish to spare their youngsters from this psychological distress will seek and demand any form of medical, dental or cosmetic intervention at an early age, often just before the child is about to begin school.

**PROSTHODONTIC MANAGEMENT**

The face, especially the oral region is central to all contact and interpersonal communication. The mouth itself is instrumental in chewing, speaking and expressing emotions and thoughts, all activities necessary in daily life.

Facial disfigurement may be congenital, traumatic or infectious. The commonly seen congenital defects include cleft lip and/or palate, partial anodontia, amelogenesis imperfecta, dentinogenesis imperfecta, and ectodermal dysplasia.

These problems may present as dental deviations in size, position, appearance and number of teeth, as well as facial variances such as decreased vertical dimension, decreased facial support, lack of occlusion, incompetent lips, altered speech, tooth wear and sensitivity.¹¹

Many clinicians (and parents) feel that the dental concerns should be addressed as soon as they present in order to spare the patients (and their families) from negative psychological consequences.² However, no interventions should be contemplated before there has been a multi-disciplinary consultation, and a comprehensive treatment plan has been drafted outlining the immediate, short term and anticipated future needs. In some situations immediate treatment soon after birth is required to aid feeding and/or breathing.

Any other early intervention, especially for aesthetic concerns alone, needs careful consideration. While it may be beneficial in reassuring the parents that they have help and support, it must not be to the detriment of future treatment or oral health.

The more difficult prosthetic decisions concern those children who are about to begin school. Parents and teachers often put pressure on dentists to carry out treatment that will improve the child’s appearance and spare them from teasing and stigmatization.

Restorative options may be very limited and will depend on the child’s age, their particular anomaly, the appearance, quality, distribution and number of teeth present, and the radiographic assessment of all developing, but as yet unerupted permanent teeth. Conceding to unrealistic expectations and demands to treat can carry physical and psychological risks for the patients.³

Nowak cautioned that “Any clinicians who decide to treat paediatric patients with congenital defects must be knowledgeable in growth and development, behaviour management, techniques for fabrication of specialised prostheses, conservative modification of existing teeth, have the ability to motivate the patient and the parent in the use of the prosthesis, be responsible for the follow-up maintenance, modification and replacement of the prosthesis and have a plan for the long-term definitive treatment”.¹⁰

If not competent in all of these areas, the practitioner should consult with other specialists, or refer the patient if necessary. Regardless of the individual clinician’s experience and expertise, management of all children with congenital defects is best handled by a multi-disciplinary team.

This may comprise a paediatric dentist, prosthodontist, orthodontist, maxillofacial surgeon, ear nose and throat specialist, speech therapist, psychologist, social worker, and should include the parents, with each performing care in their particular field if and when it is indicated.

There are no guidelines as to the best time to begin treatment. Some clinicians may feel that an initial appliance should be placed before the child begins school to give them a reasonably normal appearance and allow them time to adapt.¹² However, this decision must be based on their ability to manage the child, the oral condition at that time as well as the child’s ability to withstand dental procedures - including consideration of the need for general anaesthesia.

The parents may also facilitate or impede the success of the treatment. It is important that they, as well as the patient, understand what is involved in each procedure, the anticipated outcome, what the appliance will look like, how it will benefit the patient, how much adaptation may be needed, how to care for it, the number and frequency
of visits that will be needed for post insertion modifications or replacement, possible risks or damage that the treatment may cause to any teeth or other oral structures, and limitations of the treatment.\textsuperscript{12}

A good outline of possible prosthodontic options for children with congenital dental defects was presented by Kanaparthy and Kanaparthy (2015).\textsuperscript{11} These include:

1. Fixed partial dentures

These are rarely used because these children often have a limited number of teeth, and their position and spacing is seldom ideal. There is risk of pulp exposure when cutting young teeth with large pulp chambers. Rigid fixed prostheses may interfere with jaw growth, especially if they cross the midline.

2. Individual crowns

While individual crowns will not restrict jaw growth they still carry the risk of pulpal exposure in young teeth. Teeth may also not be fully erupted and thus have short clinical crowns which could compromise retention.

In the anterior region, the crown margins may become exposed once the teeth have fully developed and the unaesthetic crowns will then need to be replaced.

Pulpal exposure in patients with dentinogenesis imperfecta is a problem as endodontic treatment is extremely complicated due to pulpal obliteration.\textsuperscript{2}

3. Direct composite restorations and veneers

These are ideal for restoring normal form, function and aesthetics to malformed teeth. They are minimally invasive and easily replaced when needed.

4. Partial and complete removable prostheses

These are the most common form of treatment as many congenital defects present with anodontia, hypodontia, malformed or malpositioned teeth.

Removable appliances include partial dentures, complete dentures, removable appliances carrying an obturator or speech bulb extension as well as removable appliance used in conjunction with orthodontic mechanisms.

Child patients requiring complete dentures often have underdeveloped ridges and will struggle with retention, speech and mastication when wearing a complete removable denture.

5. Overdentures

If there are any teeth, no matter how small, misshapen or deformed, they will help retain and stabilize an overdenture. The added advantage of overdentures especially in patients with cleft palate defects is that retention of teeth helps maintain and preserve the alveolar bone, while the denture itself can be used to bulk out an underdeveloped maxilla.

Overdentures are also ideal in patients with dentine dysplasia, as the teeth usually have shortened roots and are thus lost at an early stage. The overdentures are then easily converted to complete dentures.\textsuperscript{2} They are similarly suited to children suffering from anodontia.

6. Bleaching and micro-abrasion

These have been used in patients with severe tooth discoloration prior to placing composite resin or bonded ceramic veneers or full coverage restorations.

Some patients with Amelogenesis imperfecta may require periodontal surgery to extend crown lengths or reduce hyperplastic tissue,\textsuperscript{2} but this is particularly invasive and traumatic for a child.

7. Implant supported prostheses

There is much literature to support the psychological and physical benefits of implant supported prostheses in patients with congenital defects.

However the consensus opinion is that they should only be placed after maximum jaw growth has occurred which is estimated to be at around 15 years of age.\textsuperscript{13}

There are many prosthodontic options available to treat children with inherited dental anomalies. While the possible improved aesthetics and assumed psychological benefits of intervening at an early age may tempt clinicians to treat, there is a need to be aware that there are also many less obvious dental complications as well as physical and psycho-social disadvantages. These include, but are not strictly limited to the following:

- unretenitive prostheses that may hamper mastication or speech and be socially embarrassing to the child. Trying to force them to wear such an appliance for aesthetic purposes could traumatize them more than the psychological issues already associated with having a deformity.
- they invariably miss a fair amount of school time, extra-curricular activities and social functions while they are undergoing treatment and recovery. This can add to their already compromised academic and social development, and could further impact on their low self-esteem.
- they may experience extreme discomfort, and suffer from iatrogenic dental damage as a result of the tooth preparations required to accommodate a prosthesis.
- appliances need to be regularly adjusted to permit continued tooth development and eruption. If this is not monitored closely they can cause extensive damage and even tooth loss which will jeopardize future treatment options. Who is responsible to ensure the child returns for these scheduled visits, the clinician who inserts the prosthesis or the parents, and who should be held liable for damage caused by lack of compliance?
- surgical procedures carry a risk of scarring and tissue contraction, which result in a poor denture foundation when compared with normal healthy oral mucosa.
- root resorption from accelerated orthodontic tooth movement, especially if it is carried out without consulting specialists in the field, or from manipulation of teeth with deficient root structures.
• instilling a fear of dentists into a child at such an early age may impact on how they view their oral condition and therapy for the rest of their lives.

• finally, there is the ethical issue of whether it is justified to expose children to multiple radiographic procedures, frightening and often painful dental treatment, or repeated sessions of sedation and general anaesthesia.

CONCLUSIONS

In an ideal world dentists would be able to provide prosthodontic treatment that would improve aesthetics and function, not compromise oral health and simultaneously address the child’s psycho-social needs.

However, ideal seldom exists. In those situations where there is a dilemma in deciding between prosthodontic intervention and delayed treatment, it may be necessary to also consider the patient’s "quality of life". This includes physical health, personal circumstances, social relationships and functionality.

The authors cannot dictate which treatment approach should take precedence. Is it better to succumb to parental pressure and treat the dento-facial condition at any cost in order to improve the appearance and psychological well-being of the child, or should there be minimal initial intervention, if doing so will benefit long term future oral and dental health?

The literature has as many proponents as opponents for each argument - with some expressing extreme views such as:

- "We as dentists can harmonize and normalize the face and health of those with unattractive facial features. In so doing we are able to offer these children a life they may not otherwise achieve: an equal opportunity for health, happiness and success. We wield the power within our fingertips to intervene professionally and change their lives in a positive way. This is a supreme gift bestowed upon us - a gift that we should use wisely and responsibly." 6

As opposed to:

- Until the world is able to see that true beauty cannot and should not be defined or outlined by a perfect set of measurements or in a finite list of attributes, it will leave many people the poorer as they will miss out on appreciating the talents, virtue, and soul of their fellow human beings.

Beauty does not reside in the eyes but rather in the heart. It manifests itself in the acts of kindness and compassion shown to others, in how people relate, learn from and teach each other, and in the respect they show for all of creation. In that respect, everyone is already beautiful. 7

We will welcome feedback and opinions from colleagues. We guarantee that confidentiality and anonymity will be maintained and look forward to present these comments in the form of a lively debate, in a follow up publication.

References


Continuous Professional Development questionnaire

This edition is accredited for a total of 3 CEUs: 1 ethical plus 2 general CEUs

GENERAL

The burden of head and neck cancer in Africa: The status quo and research prospects

True or False:

1. Educational levels and existing religious/cultural beliefs can influence the burden of oral cancer in men of African descent.
   a. True
   b. False

Multiple choice: Identify the correct answer.

2. Identify which of these countries does not have a high burden of oral cancer.
   a. South Africa
   b. Sudan
   c. Germany
   d. Kenya

3. Identify which of the following factors does not contribute to an increasing incidence of head and neck cancer in Africa.
   a. Regular exercises
   b. Smoking habits
   c. Westernization in lifestyle and diet
   d. HIV/HPV

4. Identify which of the following countries does not have a low burden of head and neck cancer.
   a. United Kingdom
   b. Germany
   c. United states of America
   d. France (La Reunion)

The relationship between oral candidiasis and micronutrient deficiency amongst adult tuberculosis patients in Alexandra, Johannesburg

Multiple choice: Identify the incorrect statement.

5. Patients living with AIDS are particularly vulnerable to extensively drug-resistant tuberculosis because of:
   a. their increased susceptibility to infection through nosocomial transmission
   b. malabsorption of TB medication
   c. acquired rifampicin resistance
   d. their rapid excretion of the drugs
   e. poor response to TB therapy

Dental management of patients with inherited bleeding disorders: a retrospective study

Multiple choice: Identify the incorrect statement.

6. There was a significant association between the presence of oral candidiasis in TB/HIV co-infected patients and:
   a. Zinc-, Vitamin A- and Vitamin D- deficiencies
   b. Selenium, Vitamin A- and Vitamin D- deficiencies
   c. Iron, Zinc and Selenium deficiencies
   d. Vitamin D, Selenium and Zinc deficiencies

Identify the correct statement.

7. The administration of DDAVP 30 to 60 minutes before an invasive procedure is clinically effective in patients:
   a. with a moderate form of haemophilia A
   b. with type 1 Von Willebrand disease
   c. with a severe form of haemophilia A
   d. with type 2 Von Willebrand disease

Identify the correct statement.

8. In this study, post-extraction bleeding was experienced in haemophiliac patients:
   a. immediately
   b. within two hours
   c. never
   d. several days later

True or False:

9. In the more severe bleeding cases, FRT and TA was administered both intravenously and orally.
   a. True
   b. False

Root canal treatment in mandibular canines with two roots: A review of the literature and a report of three cases

Multiple choice: Identify the correct statement.

10. The literature has recorded the prevalence of two rooted mandibular canines to vary between:
    a. 3,4% and 14%
    b. 1,3% and 12,1%
    c. 4,5% and 10,4%
    d. 2,7% and 16,2%
11. Despite the capacity of the 3D Endo Software (Dentsply Sirona) to rotate the image, it is not possible to use the system to assess the angle and direction of curvatures in the root canal systems.
   a. True
   b. False

Oral health status of sentenced offenders in KwaZulu-Natal Province

Multiple choice: Identify the correct statement.

12. The most common dental procedure offered in correctional centres located in KwaZulu-Natal (KZN) is
   a. Scaling and Polishing
   b. Conservative Dentistry (Restoration)
   c. Root Canal Treatment
   d. Extraction of teeth (Exodontia)
   e. None of the above

13. The Department of Correctional Services (DCS) at the end of its 2015/2016 financial year, reported that the total inmate population in South Africa was:
   a. 161 984, with an approved bed space of 119 134 which translated to an occupancy rate of 135.96%
   b. 170 984, with an approved bed space of 119 134 which translated to an occupancy rate of 145.52%
   c. 161 988, with an approved bed space of 119 134 which translated to an occupancy rate of 135.98%

Antibiotic prescribing practices of dentists at Medunsa Oral Health Centre

Multiple choice: Identify the correct statement.

14. Antibiotics are unnecessary in
   a. Irreversible pulps
   b. Necrotic pulps
   c. Localised acute apical abscesses
   d. All of the above
   e. None of the above

15. In dentistry, antibiotics are typically prescribed for the following purpose(s)
   a. As treatment for acute odontogenic infections
   b. As treatment for non-odontogenic infections
   c. As prophylaxis against focal infection in patients at risk (endocarditis and joint prostheses)
   d. As prophylaxis against local infection and systemic spread in oral surgery
   e. All of the above
   f. None of the above

16. The prophylaxis guidelines applied in South Africa are recommended by
   1. American Heart Association (AHA)
   2. European Society of Cardiology (ESC)
   3. British Society for Antimicrobial Chemotherapy (BSAC)
   4. All of the above
   5. None of the above

Maxillo-Facial Radiology 164

True or False:

17. Osseous ankylosis is a fibrosis of the mandibular condyle with part of temporal bone
   a. True
   b. False

18. The most frequent causes of ankylosis are traumatic injuries and infection
   a. True
   b. False

What's new for the clinician – summaries of recently published papers (September 2018)

True or False:

19. The findings of the Türktekin et al study suggest that RP with diamond burs is significantly superior when compared with curettes.
   a. True
   b. False

20. In the Keskin et al trial, there were significant differences between gender and the postoperative pain in either group.
   a. True
   b. False

ETHICS

Deciding on prosthodontic treatment in children with inherited dental abnormalities: Should psychological or dental well-being take precedence?

True or False:

21. There are no ethical considerations when planning the management of inherited dental anomalies which may be associated with other defects and could result in profound negative consequences for the individual and their families.
   a. True
   b. False

22. The paper implies that undertaking treatment to satisfy the pursuit of perfection in the obsessive attempt to attain the perfect look is unrealistic and not ethical.
   a. True
   b. False

23. When there is parental pressure to deliver treatment to avoid psychological distress in the child, the ethical practitioner would not contemplate any interventions before there has been a multidisciplinary consultation, and a comprehensive treatment plan has been drafted outlining the immediate, short term and anticipated future needs.
   a. True
   b. False
24. If a practitioner is not competent in all of the treatment modalities which may be involved, ethical and clinical principles indicate that the practitioner should consult with other specialists, or refer the patient if necessary.
   a. True
   b. False

25. There are ethical issues in the decisions to expose children to multiple radiographic procedures, frightening and often painful dental treatment, or repeated sessions of sedation and general anaesthesia.
   a. True
   b. False

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NOTICE OF 19th ANNUAL GENERAL MEETING (AGM) OF The South African Dental Association NPC (“SADA”)

Notice is hereby given that the 19th Annual General Meeting (AGM) of the South African Dental Association (SADA) will be held at the SADA Head Office, 31 Princess of Wales Terrace, Parktown, Johannesburg on Thursday 14 March 2019 at 18:00 followed by snacks and refreshments. The Agenda for the meeting will be posted on the SADA website.

SADA is your association and your voice counts.

KC Makhubele
Chief Executive Officer
28 September 2018

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Do the CPD questionnaire on page 536

The Continuous Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

Online CPD in 6 Easy Steps

1. Go to the SADA website www.sada.co.za.
2. Log into the ‘member only’ section with your unique SADA username and password.
3. Select the CPD navigation tab.
4. Select the questionnaire that you wish to complete.
5. Enter your multiple choice answers. Please note that you have two attempts to obtain at least 70%.
6. View and print your CPD certificate.
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The Editorial Assistant, Mr Noko Reagan Mojela, South African Dental Journal, South African Dental Association [SADA], Private Bag 1, Houghton 2041, South Africa. Electronic addresses: NMojela@sada.co.za and bill.evans@wits.ac.za.

Language
All articles must be submitted in English. Spelling should be in accord with the Shorter Oxford English Dictionary.

Title
To be kept as brief, clear and unambiguous as possible.

Summary
The summary shall consist of not more than 200 words. This applies to both research and review articles. For research articles, the summary should be structured under the following headings: introduction, aims and objectives, design, methods, results and conclusions.

Text
Please submit the paper in electronic format to NMojela@sada.co.za and to bill.evans@wits.ac.za, accompanied by a covering letter signed by the author(s). The paper should be submitted in a single file including all Tables and Figures and their accompanying Legends. Articles should be clear and concise.

Text should be typed in Times New Roman font, size 11; double-spaced with a 3 cm margin on sides, top and bottom. Each page must be clearly numbered. Tables should clearly identified, using Arabic numerals ie. Table 1, Table 2 etc. The front page of the manuscript should list the title of the article, the author(s)’s name(s), qualification(s), affiliations and positions held, telephone and fax numbers and address(es), including e-mail address(es) if available. It is especially important that details of the Corresponding Author should be clearly stated. Please submit on the front page a list of up to eight Key Words.

In the case of multiple authors, the role played and the respective contribution made by each should be recorded. For example “principal researcher, writing article, tissue analysis, microscopic examination etc. Authors are requested to note and adhere to the current style of the Journal particularly with respect to paragraph settings and headings.

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Continuing Professional Development
Please supply 5-8 questions related to your article, at least three of which should be in the multiple choice format. Answers must be either True or False or, if multiple choice, have only one correct answer. Please provide answers to the questions.

References
References should be set out in the Vancouver style and only approved abbreviations of journal titles should be used (consult the List of Journals Indexed in Index Medicus for these details at: http://www.nlm.nih.gov/tsd/serials/lji.html). References should be inserted seriatim in the text using superscript numbers and should be listed at the end of the article in numerical order. Do not list them alphabetically. It is the author’s responsibility to verify each reference from its original source. Please note that an article may be rejected if the referencing is inaccurate.

Names and initials of all authors should be given unless there are more than six, in which case the first three names should be given, followed by ‘et al’. First and last page numbers should be given. Where it is applicable the page numbers should be abbreviated by omitting redundant numbers eg pages 456 to 478 is recorded as 456-78, and 456 to 459 as 456-9, but 398 to 401 is recorded as 398-401. Notice that volume numbers are not given in bold, authors are not linked by ‘and’ or ‘&’, and the date of publication appears after the name of the Journal. No item should appear in italics except for foreign terms, eg in vivo.

Journal references should appear thus:
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