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C O N T E N T S

EDITORIAL

HUMAN RESOURCES FOR HEALTH IN SRI LANKA

The health workforce can be defined as "all people engaged in actions whose primary intent is to enhance health". Within many health care systems worldwide, increased attention is being focused on human resource management (HRM). Over the years, human resource has been recognized as the key health system input, perhaps more important than the other two major inputs, namely physical capital and consumables.

Health workers in Sri Lanka are mainly educated and trained through domestic public education programmes conducted either by the state-funded universities or the Ministry of Health. The domestic education of medical professionals is almost completely funded through the University Grants Commission (UGC) and the Ministry of Higher Education. The universities under the UGC are fully financed by the government and undergraduate students are not required to pay any tuition fees. This zero-tuition policy, matched with guaranteed employment in the state sector for all medical graduates, relatively high wages and a large set of benefits for medical officers, combined with the possibility of dual employment in public and private sectors, makes studying Medicine a very attractive option. Since the number of places to study Medicine in the state funded universities under the UGC has remained relatively static (at about 1,100 - 1,200) over the last decade, the latter factors have probably contributed towards a marked increase in the number of Sri Lankan

students who have chosen to pay tuition fees and study Medicine abroad. Foreign medical graduates are required to pass a licensing examination conducted by the Sri Lanka Medical Council (Examination for Registration to Practice Medicine, ERPM) before they are granted registration to practice Medicine in Sri Lanka. The number of candidates completing the ERPM has doubled, from just over 100 in 2010 and 2011, to an average of more than 200 per year in the four-year period 2014 - 2017. Thus, foreign medical graduates now comprise about 15% of new entrants to the medical workforce. Number of foreign dental graduates too have arisen in past 10 years.

Moreover, based on estimates of students currently studying Medicine and dentistry overseas, a recently published system dynamics model of the medical workforce in Sri Lanka predicted that this figure would rise to about 500 by 2023/24.

Domestic production of medical and dental graduates is also set to rise substantially in the next few years. 150 - 200 more doctors will graduate a year from the now-defunct SAITM and KDU, and another 200-250 from three new state medical faculties. Moreover, new Dental Faculty is planned to be established at University of Sri Jayewardenepura in 2022.

The training of nurses for employment in the Ministry of Health, is conducted in 18 Nurse Training Schools (NTS) run by the same Ministry. Those who complete the 3-year training programme offered by the NTS are awarded a Diploma, since the Ministry of Health has no degree awarding institutions under its purview. All nursing diploma holders trained by the Ministry of Health have thus far been automatically absorbed to Government service. Six of the state-funded universities now offer BSc Nursing degree programmes, with a combined annual intake of about 350. Although there is a clear international distinction between

recognition of nursing degrees obtained at a university, and nursing diplomas, in Sri Lanka, they are considered equivalent and follow the same pay structure. On a more positive development, currently UGC is working to establish a separate Nursing university and utilize the training facilities (nursing schools) of the Ministry of Health to train students. Hence it could be assumed that in future Sri Lanka will produce only graduate nurses. The large private hospitals have created their own training programmes for nurse assistants. However, the private sector training programmes and the nurses trained by them remain unrecognized by the Nursing Council of Sri Lanka and by the Ministry of Health for employment purposes.

Training for the five Professions Supplementary to Medicine (PSM) categories (Radiographers, Medical Laboratory Technologists (MLTs), Physiotherapists, Occupational Therapists and Pharmacists), and Paramedical personnel, including Primary Health Care providers (Public Health Inspectors and Public Health Midwives) are also done by the Ministry of Health. The Ministry of Health pays a relatively substantial monthly allowance of around Rs 36,000/ for all students (Nursing, PSM and Paramedical) during the training period. The state universities also have a limited intake for four-year bachelor's degrees in Pharmacy, Medical Laboratory Sciences, Physiotherapy, Radiography and Speech & Hearing Sciences. This shift from training of allied health personnel within the health services, to university-level education, reflects a global change.

An aggregate density of 4.45 physicians, nurses and midwives per 1,000 population has been identified by WHO as the workforce threshold required for 25% achievement of a composite SDG index. This WHO threshold suggests that Sri Lanka requires a total of at least 102,000 physicians, nurses and midwives. The latest figures available at HR unit of the Ministry of Health as of June 2020, the Line Ministry and

Provincial Councils employed 22,097 doctors; 44,174 nurses (including nursing students); 8,687 midwives. These figures suggest that Sri Lanka had an aggregate density of only 3.44 physicians, nurses and midwives per 1,000 population in 2020. However, since this figure includes only Ministry of Health employees, the true rate is probably somewhat higher since there are other contributors to the health workforce. There is limited information on the workforce in the private sector, but it has been estimated that around 3,050 doctors are either full time general medical practitioners or are employed full time in the private sector, while the defense establishment has about 320 medical practitioners, and the university system has about 625 medically qualified persons in their permanent cadre, thus bringing up the total number of doctors working in Sri Lanka to approximately 26,000. Since there are negligible numbers of fully qualified nurses and midwives in the private sector, it would appear that the total number of physicians, nurses and midwives in Sri Lanka adds up to about 79,000 at present - a shortfall of approximately 23,000 physicians, nurses and midwives.

It is estimated that each year, the Ministry of Health recruits about 1,300-1400 medical officers, 75 dental surgeons, 275 medical specialists, 3,000 nurses and 1,000 paramedical staff into the system. Since this works out to an average of about 4,500 more physicians, nurses and midwives a year, then it is possible that the gap may be met in approximately 5-6 years.

Training of Health workers specially doctors and dental surgeons takes a long duration of time. Hence, whatever the decision we take today, either to produce more or to curtain training, the effects of which will manifest only after 5-6 years. Therefore, number of medical students or dental students to be trained annually should be decided after a careful scientific analysis. Either too many doctors/dental surgeons or too little will be catastrophic. The former been too dangerous than the latter.

Given the presence circumstances, where the economy remains in a precarious state; Sri Lanka is facing a deepening financial and humanitarian crisis with fears it could go bankrupt in 2022 as inflation rises to record levels, food prices rocket, and its coffers run dry. To make things worse, the foreign exchange crisis has combined with the heavy economic backlash of the COVID pandemic to severely impact Sri Lanka's growth, which was highly dependent on tourism, investments, exports, and remittances - all sectors vulnerable to the pandemic. In this backdrop, proper scientific planning of Health Human resources become even more critical.

Dileep De Silva Shyama Banneheka
Co-Editors SLDJ

(Some parts of this editorial is extracted from Dileep De Silva's previous publication)

Research Article

Bacterial contamination of mobile phones used by a group of dental surgeons and students at the University Dental (Teaching) Hospital, Peradeniya

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Abstract

Objective: This study aimed to investigate the bacterial contamination of mobile phones used by a group of dental surgeons and students working at the University Dental (Teaching) Hospital, Peradeniya.

Methods: A cross sectional study was conducted using mobile phones of 30 dental surgeons (10 males and 20 females) and 30 dental students (5 males and 25 females) selected by convenience sampling and upon their informed consent. All the participants were engaged in clinical practice or training. Microbiological samples were collected from the screens of the mobile phones by application of saline moistened swabs which were cultured on blood and MacConkey agar aerobically for 24h. Afterwards, the total bacterial colony counts were recorded and microorganisms were identified using colony characteristics, Gram staining and appropriate biochemical tests. Methicillin resistance in staphylococci was assessed using cefoxitin disc diffusion assay.

Results: Majority of the swabs collected from the screens (82%; 49/60) produced at least one type of bacteria on culture and 18% (11/60) did not produce any bacterial growth. Altogether, 99 bacterial isolates (03 *S. aureus,* 70 coagulase negative staphylococci, 15 Gram positive bacilli, 05 Gram negative cocci, and 06 Gram negative bacilli) were collected from the culture positive samples. Thus, 74% (73/99) of the isolates were staphylococci. While all the *S. aureus* isolates (100%) were methicillin sensitive (MSSA), 11% (8/70) of coagulase negative staphylococci (CoNS) isolates were methicillin resistant. All Gram negative bacilli (100%) were oxidase positive, non-lactose fermenters which were considered as *Pseudomonas* species. Mean of the total bacterial colony counts of the dental surgeons' mobile phones (31 ± 4) was significantly higher than that of the dental students' (12 ± 6) (P< 0.05).

Conclusion: Mobile phones used by the dental surgeons and students in the current study harbor many bacteria with a predominance of CoNS out of which nearly 11% was methicillin resistant highlighting the importance of the hand hygiene and regular disinfection of mobile phones.

Key words: bacterial contamination, dental students, dental surgeons, hand hygiene, mobile phones.

Introduction
Mobile phones with the introduction of multiple applications have become indispensable in every sorts of life including the health care sector. Speedy delivery of real time information audio-visually has popularized the use of mobile phones

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among health care professionals. Sometimes, mobile phones are used by the health care workers (HCW) in accessing necessary information for treatment planning, obtaining expert opinion as well as for record keeping[1]. Therefore, mobile phones are often handled by HCW while attending on patients in various health care settings raising the risk of microbial contamination. For instance, an analysis of bacterial contamination of mobile phones used by 112 HCW has shown that nearly 95% of mobile phones harbored potential pathogens such as *Staphylococcus epidermidis* (43%), *Bacillus* species (32%), *Staphylococcus aureus* (25%), *Pseudomonas aeruginosa* (20%), *Escherichia coli* (14%), *Streptococcus* species (14%), *Proteus* species (12.5%), *Klebsiella* species (7%), and *Acinetobacter* species (5%)[2]. Moreover, several investigators across the globe have pointed out that the mobile phones of HCW carry various potential pathogens together with multi drug resistant bacteria responsible for nosocomial infections[3-11]. In particular, a study conducted among anesthetists working in the surgical theatres in two Sri Lankan hospitals has isolated both methicillin sensitive *Staphylococcus aureus* (MSSA) (46.5%) and methicillin resistant *Staphylococcus aureus* (MRSA) (15%) from their mobile phones[4]. Another Sri Lankan study that has assessed microbial contamination of mobile phones of veterinary students has found eleven species of bacteria, including coagulase negative staphylococci (CoNS), *Bacillus* species and *Pseudomonas* species[11].

Mobile phones may get contaminated with both pathogens and saprophytes from the commensals of the handlers as well as from their working environment[12]. Considering the fact that many dental procedures are aerosol generating, it may be hypothesized that there is increased tendency for contamination of mobile phones when they are used in dental clinical settings. Supporting the above, in a study conducted by Shooriabi e*t al.* it has been found that all the 77 mobile phones of a group of dental surgeons were contaminated with bacteria such as *Bacillus* species, CoNS, *E.*

coli and *Enterobacter* species[13]. Furthermore, Al-Ghurabi *et al.* who have examined 30 mobile phones used by dental surgeons in Iraq have revealed that all the mobile phones were contaminated with human and environmental organisms such as *Staphylococcus epidermidis, Micrococcus species, Candida albicans* and *Aspergillus niger*[14]. Another Indian study that has assessed the contamination rates of dental health care workers (DHCW) mobile phones has pointed out that the contamination rate was as high as 98%[5]. Collectively, forgoing data denote that the mobile phones of HCW may act as an important source of potential pathogens capable of cross infecting patients as well as HCW. Nonetheless, bacterial contamination of mobile phones used by DHCW has been poorly studied in Sri Lanka.

Objective: The aim of this study was to investigate the bacterial contamination of mobile phones used by a group of dental surgeons and students who were working in the University Dental (Teaching) Hospital, Peradeniya (DTHP).

Materials and methods
Sample collection
A convenience sample of mobile phones used by 60 participants including 30 dental surgeons and 30 dental students engaged in clinical practice or training respectively at the DTHP from January to March 2018 were selected for the study upon their informed consent. Mobile phones with touch screens that had been used for more than three months were included in the study. Mobile phones with damaged or modified touch screens or mobile phone screens covered with a flap were excluded. After obtaining the informed consent from the users, microbiological specimens were collected by application of a sterile cotton swab moistened with saline on the touch screens of the mobile phones evenly[5]. Ethical clearance for the study was obtained from the ethics review committee of the Faculty of Allied Health Sciences, University of Peradeniya.

Sample processing and analysis
Collected swab samples were transported immediately to the laboratory for culture on blood and MacConkey agar. Inoculated agar plates were incubated aerobically at 37ºC for 24 h and the total bacterial colony counts on blood agar were obtained and the lactose fermenters were observed on MacConkey agar. Identification of bacterial species was done using colony characteristics and Gram stain. Further identification of staphylococci was performed with catalase test, coagulase test, and DNAse test. Methicillin resistance in staphylococci was identified using cefoxitin disc diffusion test[10,15]. Lactose fermentation and oxidase tests were used to identify *Pseudomonas* species. Means of the total bacterial colony counts gained from the mobile phones of dental surgeons and the students were compared using Student's t test.

Results
Majority of the mobile phones (82%, 49/60) had at least one type of bacteria on the screen. However, 18% (11/60) of the mobile phones did not produce any microbial growth on culture. A total of 99 bacterial isolates were found from the 49 swab samples that produced bacterial growth (Table 1).

The commonest bacteria found on the screens of the mobile phones belonged to Gram positive cocci (74%, 73/99). Out of them, 3% (3/99) were *Staphylococcus aureus* and all of them were methicillin sensitive. Meanwhile, 71%, (70/99) were CoNS out of which 11% (8/70) were methicillin resistant. In addition, 15% (15/99) of the isolates were Gram positive bacilli and 6% (6/99) were Gram negative bacilli (Table 1). All the Gram negative bacilli were oxidase positive non lactose fermenters suggesting them as *Pseudomonas* species. Moreover, 5% (5/99) of the isolates were Gram negative cocci. Mean of the total bacterial colony counts of the dental surgeons' mobile phones (31±4) was significantly higher than that of the dental students' (12±6) (P< 0.05).

Discussion
Findings of this study emphasize that the mobile phones used by DHCW often carry potential pathogens. Particularly, 82% of the mobile phone screens used by the dental surgeons and the students in this study were contaminated with numerous bacteria. However, the commonest bacteria (74%) isolated from the mobile phones belonged to staphylococci. Current findings are comparable with that of La Fouci who has reported that 78% of mobile phones used by a sample of 200 Italian HCW was mostly contaminated with *Staphylococcus* species[16]. Moreover, several other studies that have assessed the bacterial contamination of mobile phones of different HCW from various health care settings have demonstrated high rates

Table 1. Bacterial contamination of mobile phones used by dental surgeons and dental students

Type of bacteria	Number of isolates		Total isolates
	From the mobile phones of Dental surgeons	From the mobile phones of Dental students	
Staphylococcus aureus	1	2	3
Coagulase negative staphylococci (CONS)	43	27	70
Gram positive bacilli	10	5	15
Gram negative cocci	4	1	5
Gram negative bacilli	1	5	6
Total isolates	59	40	99

of bacterial contamination of up to 98%[2,17,18]. Another recent study that has investigated bacterial contamination of 30 mobile phones used by DHCW including dental students in Iraq has reported 100% contamination rate either with single or mixed bacteria[19]. Although the rate of contamination (82%) observed in the current study is slightly lower than the previously reported rates, it is conceivable that the mobile phones used by DHCW are subjected to contamination with bacteria at large. Hence, above findings highlight the importance of hand hygiene and regular disinfection of mobile phones when they are used in clinical dental settings.

Further analysis of the bacteria collected from the culture positive samples of the current study revealed that the predominant bacteria (74%) found on the mobile phones of DHCW were Gram positive cocci. Intriguingly, out of the total isolates, 3% were *Staphylococcus aureus* and all of them were methicillin sensitive. Meanwhile, 71% of the total isolates were CoNS of which 11% demonstrated methicillin resistance. In a comparable study, it has been reported that 79% of the bacteria isolated from the mobile phones of HCW were Gram-positives out of which 14% and 60% comprised *Staphylococcus aureus* and CoNS respectively[17]. Meanwhile, several other investigations testify the fact that the commonest bacteria found on the mobile phones of HCW from different health care settings belonged to *Staphylococcus aureus* and CoNS[16,18,20]. Collectively, these findings suggest that the mobile phones of DHCW are vulnerable to be contaminated with staphylococci with a predominance of CoNS.

On the other hand, it is important to note that all *Staphylococcus aureus* isolates were MSSA while 11% of CoNS, isolates were methicillin resistant. This indicates that methicillin resistance persists within a considerable proportion of CoNS found on the mobile phones of DHCW in the present study. Therefore, considering the fact that antimicrobial resistance in staphylococci is

a major threat to health care system nowadays, it is important to raise the awareness of judicial use of antimicrobials in clinical dental practice. Meanwhile stringent infection control measures are required to prevent dissemination of resistant isolates among patients and HCWs.

In addition, Gram positive bacilli made 15% (15/99) of the total isolates obtained from the mobile phones of DHCW in this study. Resembling this observation, Nwankwo *et al*. have reported that 32% of a sample of 112 mobile phones of HCW harbored *Bacillus* species which is a Gram positive bacilli[2]. Furthermore, Gram positive bacilli including *Bacillus* species and *Corynebacterium* species have also been isolated from the mobile phones of HCW previously[20]. However, current study has not looked at the species levels of the Gram positive bacilli isolated due to the limited resources. Considering Gram positive bacilli as significant contaminants of the mobile phones of DHCW, further investigations into the species levels may be useful in the future. Furthermore, the current study showed that both Gram negative bacilli and cocci were present on the mobile phones of DHCW. Nearly, 6% (6/99) of the total isolates in this study were Gram negative bacilli whereas about 5% (5/99) of the total bacterial isolates belonged to Gram negative cocci. Intriguingly, all the Gram negative bacilli were oxidase positive non lactose fermenters suggesting them to be *Pseudomonas* species. According to a comprehensive study that has used a sample of 112 mobile phones of HCW, it has been reported that Gram negative bacilli such as *Pseudomonas aeruginosa* (19.6%), *Escherichia coli* (14.3%), *Proteus* species (12.5%), and *Klebsiella* species (7.1%) and Gram negative cocci such as *Neisseria* species may be found as contaminants[2]. Similarly, Akinyemi *et al*. have also suggested that *Pseudomonas aeruginosa, Escherichia coli,* and *Klebsiella* species are some common Gram negative bacilli that may be present on the mobile phones[21]. Aforementioned Gram negative bacteria are important in terms of nosocomial infections. Identification of 6%

of *Pseudomonas* species out of the total isolates in the current study supports the foregoing observations that mobile phones are subjected to contamination with *Pseudomonas* species[2].

Finally, it was found that the mean of the total bacterial colony counts of the samples from the mobile phones used by the dental surgeons was significantly higher than that of the dental students (P < 0.05). Above finding indirectly denotes that the mobile phones used by the dental surgeons are more contaminated than the phones of the dental students. The reason for this disparity could be attributed to two reasons. Firstly, an experienced dental surgeon handles a bigger number of patients per session when compared with a dental student. Secondly, dental students are not allowed to use mobile phones freely when they are attending on patients in the clinics. Therefore, it may be hypothesized that the mobile phones used by the dental surgeons are more prone to be contaminated compared to the phones of the dental students in this study sample. On the other hand, most of the oral bacteria that may have contaminated the hands of DHCW are fastidious anaerobes. Consequently, contamination rates may have been underestimated since this study was based on basic aerobic microbial culture techniques only. Therefore, further studies using anaerobic culture or molecular techniques may be useful to explore the microbial contamination of the mobile phones of DHCW.

Conclusion

In conclusion, this study demonstrates that the mobile phones of DHCW are subjected to contamination with numerous bacteria predominantly CoNS. With the availability of antibiotic resistant bacteria, DHCW should disinfect their mobile phones periodically and adhere to strict hand hygiene practices.

Acknowledgement

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Clinical Update

Diagnosing periodontal disease - An insight to the new classification of periodontal diseases and conditions

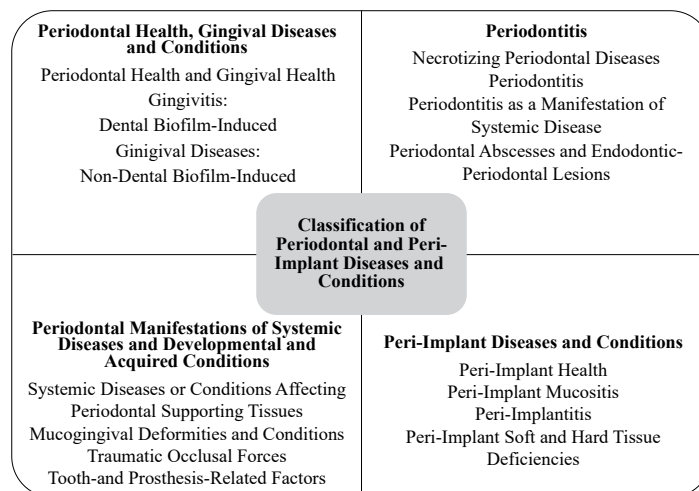**Dhanushka Leuke Bandara**

Abstract
Periodontal diseases and conditions encompass a wide presentation. Thus, a guided approach commencing with basic periodontal screening provides a better diagnostic pathway for any periodontal presentation. This paper illustrates the new classification on periodontal diseases and conditions with two common clinical scenarios explaining the algorithm in arriving at the periodontal diagnosis.

Keywords: Periodontal classification, Periodontal diagnosis, Periodontal screening, Endo-periodontal lesion.

Introduction
With the release of a comprehensive periodontal classification brought together by the European Federation of Periodontology (EFP) and the American Academy of Periodontology (AAP) in the year 2018, a new chapter was opened in the field of Periodontology[1]. Compared to the 1999 AAP classification, the new system focuses on all main aspects including periodontal health, periodontal diseases and conditions, as well as peri-implant diseases and conditions[1,2] (Figure 1). Furthermore, the criteria and the definitions for each category were formulated according to the best evidence, providing the opportunity for oral health professionals to refine their diagnoses and the treatment planning procedures with sound evidence-based practice.

Periodontal Health, Gingival Diseases and Conditions	Periodontitis
Periodontal Health and Gingival Health	Necrotizing Periodontal Diseases
Gingivitis:	Periodontitis
Dental Biofilm-Induced	Periodontitis as a Manifestation of Systemic Disease
Ginigival Diseases:	Periodontal Abscesses and Endodontic-Periodontal Lesions
Non-Dental Biofilm-Induced	

Classification of Periodontal and Peri-Implant Diseases and Conditions

Periodontal Manifestations of Systemic Diseases and Developmental and Acquired Conditions	Peri-Implant Diseases and Conditions
Systemic Diseases or Conditions Affecting Periodontal Supporting Tissues	Peri-Implant Health
Mucogingival Deformities and Conditions	Peri-Implant Mucositis
Traumatic Occlusal Forces	Peri-Implantitis
Tooth-and Prosthesis-Related Factors	Peri-Implant Soft and Hard Tissue Deficiencies

Figure 1. Classification of Periodontal and Peri-implant diseases and conditions[1]

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The status of the periodontal structures of an individual could be found in one/more of the following levels;

i. Healthy periodontium with an intact periodontium
ii. Healthy periodontium with a reduced periodontium
iii. Dental plaque induced gingivitis
iv. Non-plaque induced gingival diseases
v. Necrotizing periodontal diseases
vi. Plaque induced periodontitis
vii. Periodontitis as a Manifestation of Systemic Disease
viii. Periodontal Abscesses
ix. Endodontic-Periodontal Lesions
x. Altered periodontal attachment/health due to systemic diseases or conditions affecting periodontal supporting tissues, traumatic occlusal forces and the tooth- and prosthesis-related factors
xi. Mucogingival deformities and conditions

Similarly, in relation to the peri-implant structures;

i. Healthy peri-implant structures
ii. Peri-implant mucositis
iii. Peri-implantitis
iv. Hard- and soft-tissue deficiencies of the peri-implant tissues could be identified.

Therefore, a clinician has to consider a wide range of conditions and diseases in the diagnostic pathway rather than attempting to treat all patients as plaque induced periodontitis.

"Plaque induced periodontitis" is a chronic multi-factorial inflammatory disease associated with bacterial dysbiosis which leads to progressive destruction of the tooth-supporting structures[3]. Clinically, the progressive destruction of supporting tissues could manifest as presence of periodontal pocketing and gingival bleeding which reflects in clinical attachment loss (CAL) and radiographic bone loss. Although in the previous classification, there were two broad types of periodontitis as Chronic and Aggressive, new classification carries a single type as "Periodontitis"[4, 5]. This amalgamation was done as there was no clear evidence for specific pathophysiology that could distinguish the two entities and also due to the observation of the consistent rates of progression of periodontitis across the population[6].

Periodontitis could also be associated with endodontic lesions or as a manifestation of a systemic disease. The relationship between endodontium and the periodontium has been discussed over years and numerous classifications have been proposed. This could also be a possible missed diagnosis in presentations of localized periodontitis. In the latest classification, Endodontic-periodontal conditions are classified into two subcategories according to the presence/absence of root damage on the affected tooth. They are further graded according to the complexity of the lesion[7].

• Cases with root damage; seen with root canal/pulp chamber perforation, external root resorption, root fracture/cracking. The prognosis of this category could mostly range from questionable to poor.
• Cases without root damage; could be seen in periodontitis patients or in non-periodontitis patients due to endodontic origin.

Nevertheless, the clinician should be able to differentiate plaque induced periodontal disease from certain systemic diseases/medications which could affect the periodontal attachment apparatus or the pathogenesis of periodontal disease[8]. These two entities share a common background based on genetic and/or environmental etiological factors. However, since the affected patients may show manifestations of both diseases, diagnosing an underlying systemic disease in a patient presented with periodontal attachment loss adds an important diagnostic value and therapeutic implications for the management of the patient. These systemic diseases that could affect the periodontium are broadly categorized into genetic, metabolic and endocrine disorders

and inflammatory conditions which alter the pathogenesis of periodontal diseases at different levels. For example, periodontitis could present as a manifestation in patients with Down syndrome, diabetes mellitus, obesity and oral squamous carcinoma. Moreover, patients with severe neutropenia or those who are on cytotoxic chemotherapeutics, which could result transient or prolonged neutropenia may increase the risk for periodontitis[8, 9].

Certain acute periodontal lesions such as necrotizing periodontal diseases and periodontal abscess may also be presented as Periodontitis. In necrotizing periodontal disease, though there are classic features such as severe bleeding, pain, ulceration and papilla necrosis with rapid destruction of marginal tissues which help the clinician to differentiate necrotizing periodontal disease from Periodontitis, there could be cases presented with mild features[7]. Therefore, if any possible risk factors are detected, necrotizing periodontal disease needs to be considered as a differential diagnosis.

According to new classification, in order to confirm presence of Periodontitis, inter-proximal CAL of ≥2 mm should be detectable in ≥2 non-adjacent teeth or ≥3mm CAL on buccal/oral surfaces with pocketing ≥3 mm at ≥2 teeth[4]. However, the observed CAL should exclude the other possible reasons for apparent CAL on teeth. (Table 1)

Table 1. Common reasons for CAL

Periodontitis
Recession due to trauma
Cervical caries
Secondary to mal-positioned/partially impacted third molar
Presence of vertical root fracture
Endodontic lesions draining through the marginal periodontium

Once periodontitis is confirmed, the patient is further evaluated for staging, grading, extent, risk

assessment (RA) and the stability of the periodontal condition. Such detailed categorization would be helpful in the subsequent management of the patient (Figure 2).
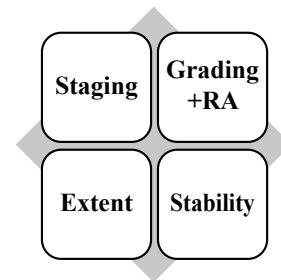
Figure 2. The parameters of Periodontitis

Staging represents the severity of the tissue loss that has been already taken place based on the maximum bone loss (BL) as well as the tooth loss due to periodontitis. Further it reflects the level of complexity in the long-term management[10]. (Figure 3)
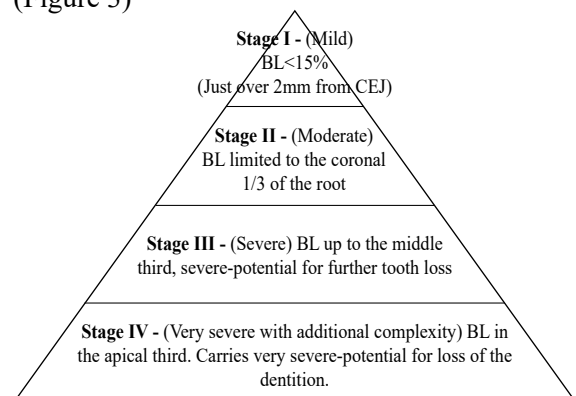
Figure 3. Severity categories in staging

Thus, cases with stage I and II could be managed easier than stage III and IV, where mostly a referral to a specialist would be necessary for the multi-disciplinary management.

Grading is associated with rate of progression of disease which dictates how fast the tissue being lost due to the disease[10]. Therefore, it is defined by rate of bone loss compared to the age of the patient and the risk of further progression of the disease due to presence of risk factors/grade modifiers. (Figure 4)
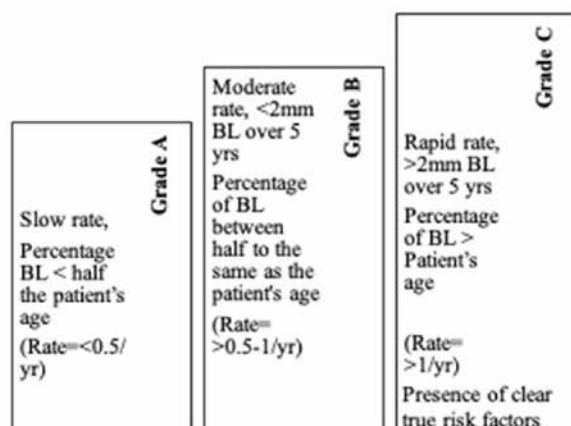
Figure 4. Grading categories

The risk factors such as sub-optimally controlled diabetes, smoking, stress could influence the disease progression as well as the treatment outcome. Therefore, the risk factors should be considered at the diagnosis stage and the appropriate risk reduction strategies should be incorporated into the management plan.

$$\text{Grading} = \frac{\text{Percentage of maximum BL}}{\text{Age of the patient}}$$

The extent of the disease determines the distribution according to the percentage of teeth affected. (Figure 5) Further, if only the molars and the incisors are affected, it could be identified separately as molar-incisor pattern.

Figure 5. Distribution of the disease
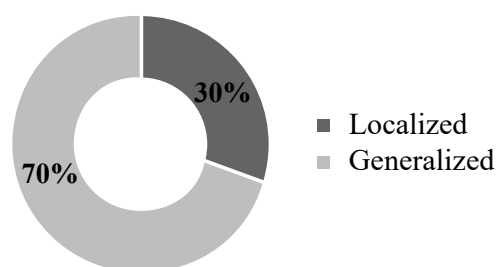
Current inflammatory status denoted by the stability of the periodontium is measured by bleeding on probing (BOP) and the range of periodontal pocket depths. A periodontium is considered stable if the BOP is less than 10% and

no pockets were found more than 4mm with no BOP on 4mm pockets[4]. In contrast, an unstable periodontium would have periodontal pockets of 4mm with bleeding on probing or depths would range from 5mm and above.

Moreover, the new classification emphasized the importance of the maintenance care by recommending to follow up a patient with periodontitis for lifetime to prevent recurrence of disease and also the importance of early diagnosis and preventive care as a patient with gingivitis could revert to a state of complete health. Therefore, if BOP was found ≥10% with the pocket depths of ≤4mm in a previously stable periodontium, it is considered as remission of the disease[4].

The following flow chart demonstrates the pathway that should be followed to reach the periodontal diagnosis from the periodontal screening (Figure 6).
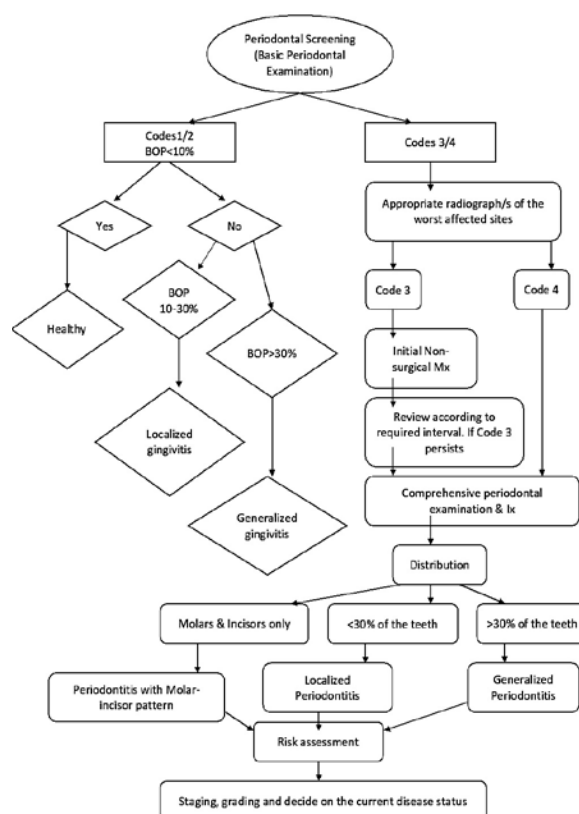
Figure 6. Pathway to diagnosis

Case 1

A 42-yr-old male was seen for a chief complaint of a loose lower tooth and bleeding during brushing. Although he was on treatment for diabetes mellitus, the glycaemic levels during last few years have not been under control. He had very high caries risk with past history of several extractions due to caries.

According to the clinical assessment and the radiographic views (Figure 7 & 8), the worst affected tooth was 42. The tooth had no trauma history and responded to the sensibility testing.

	M_2 R_5		
L	7	5	5
B	10	6	6
	R_5		

Periodontal charting of 42

What would be the diagnostic criteria according to the new classification?

This is a presentation of periodontitis in a patient with diabetes mellitus which has not shown to have a convincing control. The attachment loss was evident more than one third of the mouth, denoting a generalized distribution.

As the worst affected region showed evidence of attachment loss up to the apical one third of the root and further tooth loss is potential due to poor periodontal prognosis, the stage could be considered as stage IV.

The disease has progressed fast compared to his age, thus the grading would be 'C'.

Therefore, the diagnosis could be mentioned as, Stage IV, grade C, generalized periodontitis in a patient with diabetes mellitus as a systemic risk factor.

Case 2

A 46-yr-old lady presented with recent discomfort from the upper right region (Figure 9). She was medically healthy and no other systemic risk factors were detected. Her basic periodontal examination was as follow;

4*	2	2
2	2	2

On examination, deep, suppurative periodontal pockets were noted on palatal side of 17 and disto-palatal sites of 16.

Figure 7. Peri-apical radiograph of 42 & 31 region

Figure 8. Orthopantomogram of the patient

Figure 9. Palatal view of 16 & 17
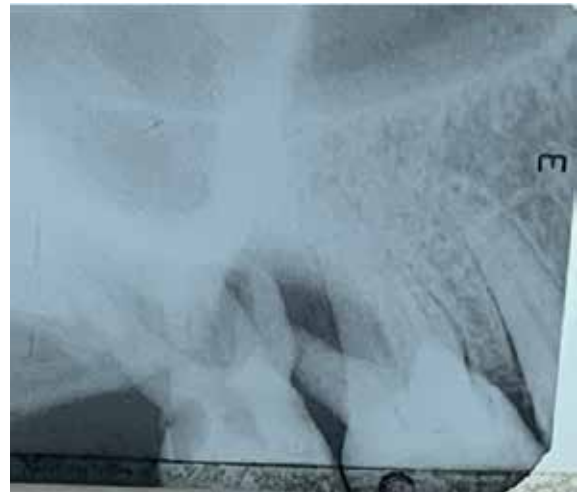
Figure 10. IOPA radiograph of 16 & 17 region

Chart 1. Periodontal assessment on 16 & 17

	F_1M_2			R_2M_1		
B	5	6	6	6	6	5
P	10	8	8	8	7	5
	F_2R_2			F_2		

A periapical radiograph showed evidence of severe bone loss around the disto-buccal and palatal roots of 16 and mesio-buccal root of 17 (Figure 10). The molars had no restorations, and there was no evidence of root fractures. However, deep root caries was noted on 17 where the sensibility testing carried out with an electric pulp tester denoted a negative response.

According to the new classification, as there was no evidence of root damage, the main diagnosis would be endo-periodontal lesion (EPL) without root damage involved with 17, in a patient with localized periodontitis.

The lesion could be further classified according to the periodontal parameters which denotes the defect morphology. (Table 2)

Therefore, the diagnosis according to the new classification is Grade 3 Endo-periodontal lesion, without root damage involved with 17.

Table 2. Grading Endo-periodontal lesions

	Grade 1	Grade 2	Grade 3
Periodontal pocket presentation	Narrow, deep	Wide, deep	Deep
No. of tooth surfaces affected	01	01	>01

Conclusion

Thus, the new classification gives a broader insight in relation to the conditions that could present in the periodontal attachment as well as in the peri-implant structures, which helps the clinicians to arrive at a diagnosis based on an evidence-based approach.

Conflict of interest

The author of the paper declares no conflict of interest.

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An overview of implications of cardiovascular drugs in clinical dentistry Part 1 - Antiarrhythmic and cardiotonic drugs

N.S. Soysa, Rasika Herath, C.N.R.A. Alles

Abstract
Cardiovascular diseases are the most common diseases, among other medical conditions with an increased trend due to urbanization, longer life expectancy and modifiable risk factors. Moreover, cardiovascular diseases are a leading cause of morbidity and mortality worldwide. The dental practitioners may encounter patients with cardiovascular diseases more frequently than other medical conditions. Cardiovascular diseases themselves, their complications, and associated pharmacological agents have a major impact on oral/dental health and treatment. Therefore, such patients require special consideration regarding the time of treatment, type of treatment, and additional precautions before providing treatment in a safe and efficient manner. A reasonable understanding of the pharmacological agents usually prescribed for such a patient will enable the dental practitioner to manage the patients appropriately without causing untoward problems in addition to avoiding possible adverse drug-drug interactions (DDIs) with drugs they might be prescribed in dental practice. This article aims to provide an overview of pharmacological agents that are commonly used in cardiovascular diseases, the risk they pose due to DDIs with agents prescribed for dental conditions, their possible effects on dental treatments and how to overcome and avoid those problems.

Introduction
To manage the health status of their patients and to prescribe drugs, the dental practitioner/dentist should know factors that could influence the effects of prescription[1]. Patients with advanced age having declining health and more comorbidities than the general population are vulnerable to be exposed to polypharmacy. In such patients occurrence of drug-drug interactions (DDIs) is more important because it determines the quality of patient care, effectiveness and safety of drug treatment[2]. Knowledge of DDIs in dentistry is important in prescribing drugs for oral diseases as well as in decision-making in selecting appropriate premedication, sedatives, anesthesia, analgesia, and antibiotics when an invasive dental procedure has been planned. For example, local anesthetics with adrenaline are commonly employed prior to many invasive dental procedures such as root canal therapy, exodontia, and periodontal flap surgery. Adrenaline is commonly combined with local anesthetics to prolong the duration of anesthesia, to achieve hemostasis and to prevent possible systemic toxicity of local anesthetics[3]. However, the administration of an exogenous catecholamine such as adrenaline may carry a high risk in patients with uncontrolled systemic diseases such

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as untreated or uncontrolled severe hypertension, uncontrolled hyperthyroidism, and uncontrolled diabetes. According to the literature, adverse reactions following local anesthesia may range from 2.5%-11% [4]. Local Anesthetic Systemic Toxicity (LAST) is a life-threatening adverse effect that may occur following inadvertent intravenous injection or due to the usage of excessive doses as in multiple injections[5]. Good anesthetic techniques, appropriate safety dosages of adrenaline (maximum recommended doses) while avoiding DDIs may prevent such instances [6]. Many drugs are implicated in inducing adverse effects on the oral cavity many of which may mimic the local and systemic diseases. Therefore, the dentist should be able to make the proper diagnosis without misdiagnosing the condition as a systemic disease[7]. Among many medical conditions that patients have, cardiovascular diseases are the most frequently encountered medical disorder by dentists. Moreover, the number of drugs a patient usually takes for a given cardiovascular disease is high. This necessitates that dentists have an adequate knowledge on pharmacological agents including antiarrhythmics, antianginal drugs, drugs in heart failure, antihypertensives and antidyslipidemic drugs which are commonly used in managing conditions such as arrhythmia, angina, heart failure, hypertension and hyperlipidemia, respectively. This overview is an attempt to discuss the implications of cardiovascular drugs when managing such a patient who visits a dental clinic.

1. Antiarrhythmic drugs

An arrhythmia is defined as an abnormality in rate or regularity of the cardiac cycle, which is maintained by specialized neural conductive tissues including SA node, AV node and His of Purkinje system. The prevalence of arrhythmia, especially atrial fibrillation is more among elderly population in addition to the increased frequency of supraventricular and ventricular ectopics[8-10]. Arrhythmias are commonly managed with antiarrhythmic drugs alone or in combination

with non-pharmacological agents. Most of the antiarrhythmic drugs used today act on ion channels altering its' structure, dynamics and gating process[11]. According to the Vaughan Williams antiarrhythmic drug classification and the 'Modernized Classification', antiarrhythmic drugs are classified into several classes. Class I antiarrhythmic drugs are Na+ channel blockers which further divided into subgroups such as class Ia (e.g., quinidine, procainamide, disopyramide), Ib (e.g., lidocaine, mexiletine), Ic (e.g., flecainide, propafenone) and Id (e.g., ranolazine). Class II antiarrhythmic drugs are mainly β−adrenoceptor antagonist which are further divided into 5 subgroups, including IIa (e.g., carvedilol, propranolol, atenolol, bisoprolol), IIb (e.g., isoproterenol), IIc (e.g., atropine, hyoscine), IId (e.g. pilocarpine, digoxin) and IIe (e.g., adenosine). Class III drugs that inhibit K+ channels and prolong the cardiac cycle are also divided into 3 subgroups such as IIIa (e.g., amiodarone, dofetilide, ibutilide, sotalol), IIIb (e.g., nicorandil) and IIIc (e.g., blockers under regulatory review for the management of atrial fibrillation). Class IV drugs are non-dihydropyridine L-type calcium channel blockers (CCBs) and include drugs such as verapamil and diltiazem[12].

Implications in dentistry

The dental practitioners do not have to hesitate to treat a patient who is on long-term antiarrhythmic therapy with satisfactory control[11,13]. A detailed pre-operative evaluation is a must in such patients to assess the type of arrhythmia, the need of prior stabilization and to assess the risk of intraoperative arrhythmia when combined with other pharmacological agents[14]. Patients on antiarrhythmic drugs have preponderance of getting orthostatic hypotension due to cardio-depression by these drugs which is commonly seen among elderly[11,15]. Caution should be exercised when positioning such patients from supine to standing after a dental treatment as abrupt shift in posture may give rise to syncope and injuries[16,17]. The undue stress of a dental

treatment may give rise to an arrhythmia especially ventricular tachyarrhythmia in a patient with a history of a previous arrhythmic attack[13,18]. Therefore, prescription of sedatives and anxiolytics may be indicated to relieve the stress in such patients. Undergoing a dental procedure under moderate to deep sedation should be carried out under continuous electrocardiography (ECG) in order to avoid the occurrence of an arrhythmia during the procedure[10,19]. In the event of an intraoperative arrhythmia, the dental procedure should be discontinued and the patient should be administered O2 while assessing the vital signs. Lignocaine which is a class 1b antiarrhythmic agent is reserved for patients with ventricular ectopics who are not responding to the above measures[10].

Adrenaline is commonly combined with local anesthetics at a concentration of 1:80,000 in order to enhance the depth and duration of anesthesia as well as to reduce the excessive bleeding during an invasive dental procedure[5]. Adrenalin is also impregnated in gingival retraction cord to get an accurate impression of tooth in crown and bridge preparation[20]. However, adrenaline may induce an arrhythmia following systemic absorption in any cardiovascular compromised patient[21]. It is reported that about 20% of patients may experience an inadvertent intravascular injection despite aspiration while injecting local anesthesia especially, the inferior alveolar nerve block (IANB). Although healthy people can tolerate such an increase in plasma adrenaline level, this may not be in patients with compromised cardiovascular diseases[22]. Therefore, in known arrhythmic patients (ASA Grade III and IV), it is advisable to reduce the maximum amount of adrenaline from 0.2 mg in healthy individuals to 0.04 mg[21]. Therefore, careful preliminary aspiration while injecting local anesthesia and monitoring blood pressure and pulse before and after starting a dental treatment would be considered the best safe approaches when treating a known arrhythmic patient[19,21]. If the dentist has any concern, it is always advisable

to consult the patient's cardiologist before administrating adrenaline in such a patient[13]. However, ventricular fibrillation and ventricular tachycardia are considered as contraindications to use adrenaline in clinical dentistry because of the risk of sudden cardiac death[4].

Amiodarone, a widely used class III antiarrhythmic drug inhibits lignocaine metabolism by inhibiting CYP3A4 and reduces systemic clearance of lignocaine by giving rise to systemic accumulation of latter with subsequent local anesthetic systemic toxicity (LAST)[19,23]. Therefore, it is advisable to reduce any amide local anesthetic by half when treating patients who are on amiodarone. If such a patient is given fentanyl for pain management during a dental procedure involving general anesthesia, he/she may require a large dose of vasopressors instead of atropine in the event of a development of profound bradycardia, sinus arrest and hypotension[19]. On the other hand, a combination of adrenaline in a patient on propranolol may cause a hypertensive crisis. This is because adrenaline increases systolic blood pressure and heart rate whereas diastolic blood pressure is reduced[24]. Therefore, caution should be practiced when administering adrenaline to patients who are already on propranolol. Moreover, care should be taken when administering any amide local anesthetic to avoid an inadvertent intravascular injection to patients who are already on lignocaine as an antiarrhythmic[25]. Macrolides such as erythromycin and clarithromycin can prolong QT and QTc interval resulting in lethal cardiac arrhythmias such as torsade de points, ventricular tachycardia and ventricular fibrillation. With simultaneous use of class III antiarrhythmic drugs such as sotalol can induce an arrhythmia especially torsade de points by more than 24 fold[26,27]. Quinidine, propafenone and amiodarone which are class Ia, Ic and class III antiarrhythmic drugs, respectively, reduce the effectiveness of codeine by limiting the conversion of codeine into its' active metabolite morphine via inhibiting the sparteine oxygenase (CYP2D6)[25]. Disopyramide

a class Ia agent is known to cause xerostomia due to its antimuscarinic activity[28]. Other class Ia drugs such as quinidine and procainamide may enhance the antimuscarinic activity of antisialogogue drugs such as atropine when they are administered simultaneously. It is considered that anticholinergic property of disopyramide is greater than both quinidine and procainamide[13,29]. Chronic use of β-blockers such as propranolol which are class II antiarrhythmic agents has been shown to reduce the total protein concentration of saliva with an increased risk of dental caries. Such drugs do not reduce the salivary flow rate which is induced by the simultaneous administration of pilocarpine[30]. Oral manifestations of antiarrhythmics are a concern for the dental practitioner as well. Quinidine may give rise to drug-induced thrombocytopenia which results in oral bleeding, hemorrhage and petechiae. Long-term use of quinidine may cause oral pigmentation. Bitter or metallic taste is experienced by some patients who are on propafenone therapy. Some patients have been shown to experience a lupus erythematous reaction for procainamide, hydralazine and quinidine[13,31,32]. Amiodarone may cause a bluish pigmentation in the skin due to photosensitivity reactions and it may also induce facial angioedema in some patients[33]. Amiodarone as well as bretylium, which is also a class III antiarrhythmic have been reported to cause taste abnormalities and salty taste, respectively[32].

2. Drugs in heart failure

Heart failure is a complex clinical syndrome that can result from any structural or functional disorder of myocardium leading to an impairment of ejection fraction and ventricular filling of the heart. This could manifest as left heart failure, right heart failure or congestive heart failure depending on the location of the failing side. Furthermore, heart failure can be classified into acute or chronic heart failure based on the time of onset[34,35]. Pharmacological agents in heart failure alleviate symptoms, improve prognosis and reduce morbidity and mortality. Major groups of drugs used in management of heart failure include diuretics (thiazide diuretics, loop diuretics and K+ sparing diuretics), angiotensin-converting enzyme inhibitors (ACEIs) (e.g., captopril, enalapril), angiotensin II receptor blockers (ARBs) (e.g., valsartan, candesartan), β-adrenergic receptor antagonists (e.g., bisoprolol, metoprolol), aldosterone antagonists (e.g., spironolactone, eplerenone), digoxin, anticoagulants, hydralalzine and isosorbide dinitrate (ISDN). Dopamine, dobutamine, phosphodiesterase III inhibitors, nitroglycerin, nitroprusside and nesiritide are considered as short-term beneficial drugs[13,35]. Out of abovementioned drugs, diuretics and digoxin are considered as the mainstay of treatment whereas ACEIs, ARBs and β-blockers are also used in most of the patients with heart failure[36]. Digoxin is a cardiac glycoside which has a narrow therapeutic index. It increases cardiac contractility (positive inotropy), reduces firing rate of SA node (negative chronotropic) and conduction velocity of electrical impulses through AV node (negative dromotropic)[19]. Digoxin is considered as a first-line agent in patients with heart failure who have atrial fibrillation whereas digoxin is used as a second-line agent if the patient has sinus rhythm[37]. Diuretics which are mainly used as symptomatic relievers, inhibit the reabsorption of Na+ at different segments of renal tubular system in order to reduce the blood volume and fluid[13,35]. They are subdivided into 6 categories namely thiazide diuretics (e.g., hydrochlorothiazide), loop diuretics (e.g., furosemide, bumetanide, torsemide, ethacrynic acid), K+ sparing diuretics (e.g., spironolactone, triamterene, amiloride), carbonic anhydrase inhibitors (e.g., acetazolamide), osmotic diuretics (e.g., mannitol) and antidiuretic hormone antagonists (e.g., conivaptan and tolvaptan)[13]. The activity of both ACEIs and ARBs is based on the neurohormonal modifications. ACEIs reduce the level of angiotensin II and increase the levels of bradykinin, nitric oxide and prostacyclin resulting in potent vasodilation. Reduced levels of aldosterone will result in inhibition of salt and water reabsorption from the kidney[38]. ARBs

selectively inhibit angiotensin II by competitive antagonism of the angiotensin II receptors resulting in reducing the angiotensin II-mediated effects such as vasoconstriction and release of catecholamines, vasopressin and aldosterone[39].

Implications in dentistry

The dentist should take precautions to alleviate the undue stress during dental procedures because it may enhance the workload on the patient's heart and stimulate the release of catecholamines which may further compromise the heart. Such formed catecholamines may temporarily reduce the plasma K+ concentration and increase the occurrence of ectopic pacemaker activity and arrhythmias as well. Risk of developing an arrhythmia is further enhanced if the patient is already on digoxin[13,40]. Even though it is rare, some patients who are on digoxin will show adverse central nervous system reactions such as nausea and vomiting when they exposed to undue stress[41]. Therefore, antianxiety and analgesic agents should be optimized in a patient with heart failure who are waiting for a dental treatment. Digoxin-induced arrhythmias not only depend on digoxin concentration but also can affect intracellular and extracellular electrolyte levels in the body. Therefore, before commencing any dental treatment, the dentists are advisable to record baseline pulse rate and rhythm in such a patient[19]. Furthermore, patients on digoxin are at a high risk of developing a digoxin-induced arrhythmia following receiving an adrenaline containing local anesthetic agent. The risk is directly proportional to the amount of systemic adrenaline concentration. Therefore, caution should be practiced to avoid accidental intravascular injections and selecting the appropriate volume of adrenaline in a patient who is awaiting an invasive dental procedure. Gingival retraction cord is contraindicated in patients who are on digoxin because a considerable amount of adrenaline can be absorbed systemically resulting in arrhythmias. In such patients, when hemostatic retraction cords are using, it should be impregnated with astringent instead of adrenaline[13]. Clinical

manifestations of digoxin depend on the actions mediated through the cholinergic nervous system. Therefore, both muscarinic and antimuscarinic drugs can influence the digoxin action. Atropine and methantheline which are antisialogogues have been shown to reduce the effects of digoxin. Therefore, atropine is used in the management of cardiac glycoside poisoning. On the other hand muscarinic receptor agonists such as pilocarpine which are used in sjogren's syndrome may enhance the effects of digoxin[42]. Macrolides such as erythromycin may alter the intestinal flora especially *Eubacterium lentum* which helps to convert digoxin into its' reducing substances. Therefore, prescribing macrolides for patients who are on digoxin may enhance the digoxin absorption through gastrointestinal mucosa resulting in digoxin toxicity[43,44]. Tetracycline has also been shown to increase the bioavailability of digoxin the same manner[45]. Excessive salivation following such therapy is an indication of such impending digoxin toxicity. Therefore, these factors should be considered before prescription of such antibiotics following dental therapy for patients who are on digoxin. Prescribing benzodiazepines such as alprazolam as an anxiolytic for patients who are on digoxin will cause digoxin toxicity due to decreased renal clearance caused by benzodiazepines[46,47]. Simultaneous administration of non-steroidal anti-inflammatory drugs (NSAIDs) such as indomethacin and ibuprofen for patients on digoxin will also result in digoxin toxicity. This implies that the dentist should have thorough knowledge regarding interactions between commonly used pharmacological agents in dentistry and digoxin in order to minimize possible risks during treatment[48,49]. Other than any pharmacological agent that can cause hypokalemia should be evaluated in patients who are on digoxin because hypokalemia will result in a fatal cardiac arrhythmia and a sudden cardiac death.

Drugs which are commonly used in dental practice such as sedatives, adrenaline, steroids

and NSAIDs can interact with diuretics which are prescribed for cardiac failure. Even though supplementary K+or dietary K+ is added to compensate for the hypokalemia caused by thiazide or loop diuretics, patients may still have ongoing hypokalemia. Therefore, special attention should be paid for patients with congestive heart failure and cardiac arrhythmia who are on diuretics because subtle hypokalemia may in the extreme event cause lethal cardiac arrhythmia depending on their underlying disease status[50]. Chronic diuretic therapy with a thiazide or loop diuretic may cause rapid and transient hypokalemia following an inadvertent injection of a local anesthetic containing adrenaline into systemic circulation, repeated multi injections or a placement of a gingival retraction cord. Simultaneous administration of diuretics with an adrenocorticosteroid such as hydrocortisone which is used both as an anti-inflammatory agent and an immunomodulator may cause slow onset and slow in termination hypokalemia even at their anti-inflammatory dosages which may be clinically inapparent until after the patient left the dental clinic[13,51]. Postural hypotension and syncope are likely to occur with thiazide diuretics than loop diuretics due to depletion of intravascular volume[52]. In such instances, co-administration of sedative-hypnotics such as benzodiazepines and opioids may further worsen the orthostatic hypotension. Therefore, it is recommended to withhold the morning dose of diuretics in the event of an intravascular sedation has been planned.

Long-term use of NSAIDs may increase blood pressure by inhibiting vasodilatory prostaglandin synthesis thereby prostaglandin-mediated blood pressure control. Indomethacin and most of the NSAIDs will reduce the antihypertensive efficacy of diuretics through above actions whereas sulindac which is a selective inhibitor of external prostaglandin synthesis does not show that effect[53,54]. Diuretics are belonged to FDA pregnancy category C with a proven risk of fetal harm. During breast feeding most of diuretics

especially hydrochlorothiazide, chlorothiazide and chlortalidone can appear in breast milk. Diuretics may give rise to dry mouth, taste disturbances, angioedema, oral manifestations due to the effects on leukocytes, lymphocytes as well as platelets, drug hypersensitivity syndrome, lichenoid drug eruption, lupus erythematous like reactions and disturbances in oral functions such as chewing, speech and swallowing[32,55]. In the event of an oro-facial angioedema which may arise within the first week of initiation of diuretic therapy will resolve when therapy is discontinued. Salivary gland hypofunction due to dehydration following diuretic therapy may cause dry mouth. Diuretics such as furosemide, amiloride and thiazides which are sulphonamides can result in agranulocytosis and allergic hematological manifestations of thrombocytopenia may present as oral manifestations. It is shown that hypersensitivity reactions may occur with furosemide and thiazide diuretics. Lichen planus eruption which is an inflammatory disorder of the skin and mucous membranes are well known to occur with thiazide diuretics due to alteration of epidermal self-antigens and activation of cytotoxic CD8+ T cells. Lesions can easily identify over buccal mucosa. Diuretics such as amiloride which is a K+ sparing diuretic reduces threshold for salt taste whereas spironolactone causes loss of taste sensation[32,33]. ACEIs may cause acute kidney injury due to a reduction of angiotensin II levels thus reducing the ability of efferent arterioles to maintain the glomerular filtration rate. NSAIDs are a known causative factor for renal toxicity. Therefore, combination of NSAIDs with ACEIs reduce the antihypertensive effect of ACEIs and increase the risk of acute kidney injury[56,57]. Dry cough and nausea are the most common side effects of ACEIs. Other relatively uncommon oral manifestations include angioedema, dry mouth, ulcerations, lichenoid eruptions, manifestations of hematological disturbances, loss of taste and scalded mouth syndrome. Drugs such as captopril, enalapril and fosinopril induce angioedema which mostly occur in tongue and lips during the first week of

initiation of an ACEI. There are some reports of angioedema with long-term treatment as well. It is believed that immunological processes and several mediator systems (bradykinin, substance P, and prostaglandins) are implicated in the pathogenesis. Loss of taste following tongue ulceration is commonly seen among patients with captopril than other ACEIs after the first 3 months of initiation and usually resolves within 2 weeks following discontinuation of the treatment. However, the risk of tongue ulceration has shown to be directly proportional to the captopril dose. Abnormal ACEI drug metabolism by the CYP enzyme is considered as a risk factor for oral ulceration. Aphthous ulcers, dry mouth and ACEI-induced neutropenia and agranulocytosis are also reported in some patients. Enalapril and captopril are considered as potential drugs to cause oral lichen planus[32,58]. Patients who are on enalapril may have minor oral bleeding and a skin rash due to sloughing off of superficial layers of mouth and lips which is similar to reactions to a variety of dentifrices and mouth rinses and is completely resolved when drugs are withdrawn. In a rare situation captopril may induce pemphigus in the oral cavity[59]. Scalded mouth syndrome is also a rare adverse effect of ACEIs such as captopril, enalapril and lisinopril which is dose-related and resolves after withdrawing of such medications. Risk factors include concurrent administration of drugs such as ISDN, thiazide diuretics, aspirin, atenolol, propranolol and nitroglycerine. Interestingly captopril can increase taste detection whereas enalapril causes metallic, sweet, salt dysgeusia and taste loss. Similar to ACEIs combination of NSAIDs to ARBs may reduce the antihypertensive efficacy of the latter[56]. Few cases of angioedema in lips and tongues are reported mainly with losartan. This can occur 24 hours to 16 months after the initiation of ARBs and resolves within a few weeks. Both quinapril and losartan may induce facial and palatal angioedema in patients with no previous allergy history. Abnormal metabolism of CYP2D6 or inhibition of that enzyme by concurrent medications is considered as the pathogenesis behind this.

Conclusion

The appropriate management of dental patients with cardiovascular diseases include obtaining a detailed medical history with a detailed drug history and patient's compliance with the prescribed regimen, a medical evaluation by the dentist as well as by the respective clinicians and monitoring the baseline vital signs. Patients with a cardiovascular disease on various pharmacological agents can be simply managed by taking simple but important steps; initial assessment of the patient by the dentist prior to dental treatment; assessment of the drug therapy including the dose and timing and possible DDIs and side effects; scheduling dental appointments according to the patient's disease status by avoiding any triggering factors and proper maintenance of the emergency drug kits including drugs such as GTN for emergency management of conditions like angina. Most cardiovascular diseases allow administration of premedication drugs to alleviate undue anxiety. Proper attention to the doses of adrenaline is required as higher doses may enhance arrhythmias. The administration of adrenaline should be done cautiously to avoid inadvertent intravascular injections. The use of adrenaline-impregnated gingival displacement cords should be strictly avoided in patients with cardiovascular diseases. Finally, the dentist should be competent in managing an emergency which may arise during the pre, intra and post-operative treatments.

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Development of a brief-inventory to assess quality of digital panoramic radiographs

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Abstract

Objective: This study was conducted to develop a brief inventory to assess the quality of digital panoramic radiographs (DPR) based on common errors and artifacts, and to test the validity of the prefinal version of the brief inventory.

Materials and Methods: In phase I; only major errors and artifacts were listed (pre-final list) by 05 dental surgeons and 05 radiographers. Two radiologists assigned the weightage for items. This was considered as the draft inventory. In the phase II, 03 radiographers, 10 final-year radiography and 10 final-year dental students scored 30 DPR images using this scale while quality of same 30 DPR images were rated by two radiologists according to a Likert scale on quality.

Results: Cronbach's alpha for scores of radiography and dental students was 0.9. The cut-off values produced using the new brief inventory showed a moderate interrater agreement (Cohen kappa=0.4, P <0.001; Chi-square 37.6, P<0.01) and row scores showed a high correlation between radiographers and students (Pearson Correlation= 0.874 P<0.001). Kendall's correlation between radiologists' subjective ratings of the quality of 30 images on the Likert scale and radiographers' scores on the new inventory was -0.416 and (P < 0.05). The ICC for the test-retest reliability was 0.6 (P<0.001).

Conclusion: The new brief inventory possesses adequate face, content and criterion validities, internal consistency, interpretability and interrater agreement and test-retest reliability.

Key words: Digital panoramic radiography, Quality assessment, Brief inventory.

Introduction
Panoramic radiography has become more popular in dental practice during the last several decades as it is quick to obtain, involves a low cost and

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gives a quick view of the entire dentition in a single frame[1,2]. The major issue with panoramic radiographs is the rendition of a distorted image. In addition, these will give rise to a less-sharp images which hinders diagnostic information[3]. However, Digital Panoramic radiography (DPR) is advantageous as post processing is possible. Hence, it can provide an image of comparatively high quality at a lower exposure to radiation[4].

In both digital and conventional panoramic radiography, occurrence of an error is possible during the following steps such as; during loading cassettes, setting exposure factors, exposing the film, while processing[5-7]. However, the most common step where errors occur is during patient positioning[8]. A DPR image is categorized as non-diagnostic under circumstances such as, the enamel and the periodontal ligament (PDL) is not visible, pathology cannot be excluded by the radiograph and if another radiograph is been wished (especially intraoral) to obtain maximum information[3]. Occurrence of errors in panoramic radiography between mixed dentition and permanent dentition has no significant difference[3]. However, errors in panoramic radiographs are reported to be more common when taken on younger patients[3].

In clinical practice, the radiographers must have an adequate experience and knowledge in avoiding known errors and creating a high-quality image for diagnostic purpose. Images of low quality require repetition that exposes the patient as well as the staff to radiation unnecessarily[1,2,7].

Therefore, taking radiographs of high quality is a very important step in the diagnostic process. The key to achieve this target would be to have a precise and accurate tool to assess the quality of the DPR images so that the radiographers will be aware on what to avoid and then send an image of high quality to the clinician. Therefore, assessment of quality of panoramic radiographs based on errors and artifacts have been investigated by several studies[8-10].

A tool that is developed to asses quality of DPR images should be validated through a proper psychometric analysis of its properties and images should be assessed accurately within minimum time duration[11].

Therefore, the present study will fill the gap of not having such a tool to assess the quality of DPR images validly and quickly by developing a brief inventory for assessing their quality based on common / known errors and artifacts reported in the literature.

Materials and Methods

The study was conducted in two phases; phase I: development of a brief inventory to assess the quality of DPR, and phase II: validation of the new brief inventory. Ethical approval was obtained from the Ethics Review Committees of the Faculty of Allied Health Sciences and the Faculty of Dental Sciences of the University of Peradeniya. Informed consent was obtained from all participants of phase I and Phase II. Written guidelines and instructions for each step in phase I and phase II were provided to all participants.

Phase I: development of a brief inventory to assess the quality of DPR images

Five Dental surgeons, five Radiographers and two Dental radiologists who were working in the Dental Teaching Hospital, Peradeniya (DTHP) with a minimum experience of five years in the respective fields were invited to take part in the phase I.

The researchers engaged in an extensive review of literature to collect all known and reported errors of DPR images. The extracted list of errors possible and important in relation to assessing the quality of DPR images was given to five dental surgeons and five radiographers. A reference guide of errors was given to them for accurate definitions of different types of errors to facilitate their task[2]. They were requested to rate against each error based on their opinion in the categorical scale: maximum effect, average

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effect, minimum effect and no effect on the quality of image. The pre-final list of errors was made based on their collective opinion. This pre-final list of errors was presented to two experienced dental radiologists to weigh each in a manner based on the significance/impact on the quality of DPR and also in a manner ultimately the scale produces a total score of 100 for an image with the poorest quality. The resulting list of errors with the weightage was considered as the new brief inventory (NBI) of quality of DPR images that were subjected to a process of validation.

Phase II: validation of the new brief inventory
Phase II was based on DPR images. Thirty deidentified DPR images were randomly selected from the archives at the Division of Oral Medicine and Radiology, DHP between January to July 2018. All these DPR images had been taken using the same digital panoramic radiographic equipment (Rotograph Evo D) which was operated according to manufacturer's guidelines by well experienced radiographers. In the validation process, two qualified dental radiologists with an experience of more than five years, three radiographers with a minimum experience of five years, and 10 final-year radiography students of the Faculty of Allied Health Sciences and 10 final -year dental students of the Faculty of Dental Sciences of the University of Peradeniya were invited to take part in the study. All images were viewed using the same laptop computer from the same distance under the same lighting conditions.

The validation of the NBI was done in several steps[11].
Criterion validity: The two qualified dental radiologists were requested to rate 30 DPR images subjectively based on the Likert scale (Optimum quality images = 3, Acceptable quality images = 2, Poor quality images = 1, Rejected quality image = 0) and a combined rating was sought in situations of any discrepancies.

The same 30 DPR images were rated using the NBI by 3 experienced radiographers and the average score was calculated for every DPR image. A correlation was established between the readings of radiologists and radiographers to establish the criterion validity.

Consistency: the same 30 DPR images were rated for quality by 10 final-year radiography students and 10 final-year dental students using the NBI. Cronbach's alpha was calculated to establish internal consistency of the NBI using their ratings. An average score for each DPR images was calculated using their ratings as well.

Interpretability: Cut-off marks were statistically established producing means and SDs with explorative statistics. The average scores of radiographers of 30 DPR images were compared with the Likert scale ratings of the radiologists to establish these cut off marks. Then using the produced cut off marks, the images were rated as optimum quality, acceptable quality, poor quality and reject on the average scores of given by students to each image. The two ratings were statistically compared to inspect the congruence of ratings.

Test re-test reliability: the same group of final-year radiography and dental students rated the same 30 DPR images with a gap of two weeks using the NBI. Their first attempt and this second attempt average scores for each DPR images were used to establish the test-retest reliability.

Data analysis
Data were managed using Microsoft Excel. SPSS (version 20) was used for data analysis. Fallowing statistical analyses were performed to validate NBI. The hypothesis that NBI has adequate validity for clinical use was tested. P value less than 0.05 was accepted for statistical significance.

Kendall's correlation and Cronbach's alpha (s) were calculated to establish criterion validity and internal consistency respectively. To evaluate interpretability, descriptive and explorative analyses were used to establish cut-off points

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for the quality and Cohen kappa value was calculated for agreement between students' rating and radiographers' rating using cross-tabulations (Chi-square). Intra-class Correlation Coefficient (ICC) was used to check re-test reliability.

Results

The participation of experienced dental surgeons, radiologists and radiographers in the development phase of the tool (phase I of the study) establishes the content and face validity of the brief inventory. The experts went through the tool in the development phase and then they prioritized the items based on their experience giving appropriate weightage (Table 1). They were confident that the new tool has covered almost all relevant areas with appropriate weightage and hence the content

validity is established. Wide, narrow or blurry anterior teeth and Washington monument were picked as errors that have the maximum impact on the quality of the DPR images.

Kendall's correlation between radiologists' subjective ratings of the quality of 30 images on the Likert scale and the average of scores given by three radiographers in rating the quality of images using the NBI was -0.416 and ($P < 0.05$).

Cronbach's alpha for scores of quality evaluation on 30 images by final year radiography students was 0.890 (N=10), final year dental students was 0.881(N=10) and Cronbach's alpha for student ratings of both groups was 0.944 (N=20).

Table 1. Weightage and score on items on the scale (problem/artifact)

Problem / Artifact	Weigh	Score
1. Wide, Narrow or blurry anterior teeth.	0.44	15
2. Washington monument.	0.44	12
3. Shark film - Lead apron above the collar line.	0.43	08
4. White vertical line on film running from top to bottom edge of film.	0.42	08
5. Opaque items.	0.38	08
6. Palate overlaps upper molars.	0.38	08
7. Unclear nasal structures.	0.38	06
8. Airspace over upper teeth.	0.37	05
9. Overlapped interiors.	0.36	04
10. Condyles pushed out.	0.34	04
11. Palate thick opaque line.	0.34	04
12. Unequal condyle height.	0.34	04
13. Hyoid ghosting.	0.33	02
14. Spine rami.	0.31	02
15. Step defect.	0.3	01
16. Gazebo effect.	0.28	01
17. Exaggerated smile.	0.27	01
18. Condyle at image top.	0.27	01
19. Wider teeth or ramus.	0.27	01
20. Reverse smile.	0.26	01

Scores were given by five dental surgeons and five radiographers based on their opinion on the categorical scale. Weightages were given by two dental radiologists in a manner based on the significance on the quality and also in a manner ultimately the scale produces a total score of 100 for an image.

Final cutoff marks for the quality of DPR images were established comparing the Likert scale values of radiologists with the radiographers' average scores of each image on the NBI. Means from explorative statistics revealed four cut of points and hence 5 levels (Table 2).

Cohen kappa value for agreement between students' rating and radiographers' rating calculated using cross-tabulations (Chi-square) was 0.4 (P <0.001). The distribution of radiographers' and students' scores (minimum and maximum) on DPR images are compared and presented in Table 3.

The Pearson correlation between the radiographers' and students' scores on 30 images with the new brief inventory (NBI) was 0.874 (P<0.001) (Figure 1).

Table 2. Final cutoff marks

Cutoff mark	Quality of the image
Below 18.8	0
18.9 – 26.7	1
26.8 – 30.5	2
30.6 – 36.4	3
Above 36.5	4

Table 3. Minimum and maximum scores of radiographers and students (final year dental and radiography) on 30 images

	Maximum Score	Minimum score
Radiographer's score	57.33	4
Students score	55.95	4.9
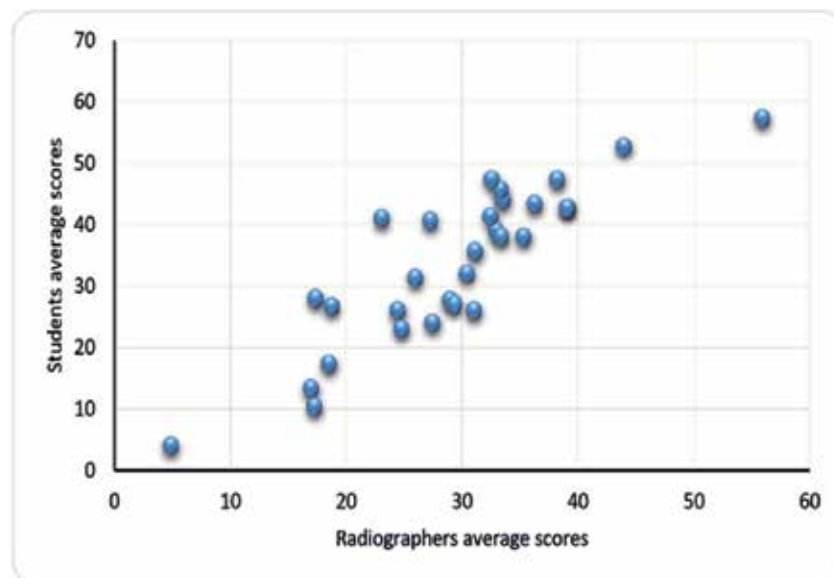
Figure 1. The correlation between radiographers' and students' scores on 30 images

Final year radiography students' first attempt scores (N=30) and their second attempt scores after two weeks were compared using Intra-class correlation coefficient (ICC). The resulting ICC was 0.6 (P<0.001).

Discussion

Quality assessment of DPR has been an important requirement of producing an optimum quality DPR image for clinical use. In this study, the main purpose was to develop a brief inventory for assessing the quality of the DPR images that would enhance the efficiency in delivering a high-quality image to the clinician.

The study revealed that wide, narrow or blurry anterior teeth and Washington monument were the errors that had the maximum impact on the quality of the DPR image[2]. Therefore, the participation of dental surgeons, radiologists and radiographers in the phase I in developing the tool ensured the content and face validity of the NBI.

In psychometric validation of the pre-final version of the NBI, the criterion validity, internal consistency, interpretability and test re-test reliability were evaluated in Phase II. In this study the combined opinion of both radiologists was considered the gold standard for criterion validity, and the radiographers' average scores exhibited a close correlation to the view of the radiologists. However, the standard expected for Kendall's correlation value is $\alpha \geq 0.7$ to be acceptable[11]. When compared to the standard set for quality criteria for measurement properties of health status questionnaires, NBI expressed a low criterion validity, which may be attributed to the use of arithmetic average of Likert ratings of two radiologists on image quality[11]. The best approach would have been to get the two radiologists to sit together and give an agreed rating on the Likert scale after considering the quality of images, as their opinion was considered the gold standard.

The internal consistency appeared to be high and acceptable having all Cronbach's alpha values above or within the acceptable range (0.7- 0.95)[11]. And therefore, the internal consistency of the NBI appears to be excellent.

Cohen kappa value for agreement between students' rating and radiographers' rating on 30 images using the NBI explains a fair agreement[11]. Perhaps the relatively less kappa value was also resulting from the use of arithmetic average of two radiologists rather than working with an agreed rating of both of them. However, scores of radiographers and students showed a significant and very high correlation with similar minimum and maximum scores on 30 images. Considering the facts that they have done their independent ratings and averages have been considered for the analysis, these observations support that the interpretability of the NBI is very high.

When compared with the Korean study on quality assessment of panoramic radiographs, this study has acceptable and valid range of values as per the standard medical equipment tool validating methods[8]. The present study reveals an acceptable test-retest reliability having a moderate ICC value.

All involved participants (experienced dental surgeons, radiologists, radiographers and students) who are responsible for quality assessment of DPR images gave their opinion and ideas in the present study. Therefore, the involvement of all relevant professional categories to this study, could be considered as a strong point of the new NBI compared to other quality assessment tools. Hence, NBI has a good and acceptable range of criterion validity, internal consistency, interpretability and test re-test reliability.

The average time that was taken by raters for one image using NBI was not measured in the present study. Further, the assessment of specificity and sensitivity was not in the study plan. Further, research may consider improving the NBI on

these lines. As discussed before, working on an agreed rating by 2 or more radiologists would be a point for improvement.

NBI included 20 common errors and artifacts that have a high bearing on the quality of DPR images. It can be concluded that wide, narrow, blurry interiors and Washington monument have the highest impact on the quality of DPR images. NBI possesses adequate face validity, content validity, criterion validity, internal consistency, interpretability and interrater agreement and test re-test reliability. Therefore, it can be considered that the NBI is in acceptable tool for use in clinical, research and other educational purposes in assessing the quality of DPR images.

Conclusion

New brief inventory is included 20 common errors and artifacts that has a high bearing on the quality of images. It can be concluded that wide, narrow, blurry interiors and Washington monument have the highest impact on the quality of DPR images. New brief inventory possesses adequate criterion validity, internal consistency, interpretability and interrater agreement and test re-test reliability. Therefore, it can be considered that the new brief inventory is in acceptable quality for use in clinical and other educational purposes in assessing the quality of DPR images.

Acknowledgement

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An audit on the extent and the quality of Prosthetic Laboratory Prescriptions written by dental undergraduates and qualified dental surgeons in a University Dental Hospital

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Abstract
Background: Communication between dentists and technicians is important for good prosthodontics outcome.

Objective: To assess the quality of prosthetic lab prescriptions written by the qualified dental surgeons and undergraduates and to highlight its importance in the undergraduate and dental technology curricula.

Methods and material: All prescriptions sent to the prosthetic lab for the complete and partial dentures at the Department of Prosthetic dentistry, Faculty of Dental Sciences, University of Peradeniya 2017 - 2019 were audited. For the presence of an instruction, a value of 2 was assigned and a value of 1 was assigned for absence. Score for all 12 items were summed up to classify the prescriptions as clear, a guide only and poor. Descriptive statistics were carried out and Chi-square test was used to test for associations between variables. Significance was calculated at the level of p value less than 0.05.

Results: Out of 2000 laboratory prescriptions, 1474 were prescribed by the undergraduates. For complete dentures, the prescriptions written by undergraduate students were clearer than dental surgeons (p=0.0005). Prescriptions written by undergraduates contained clear and complete instructions about special trays and record blocks. Both type and the material to be used in special tray were mentioned in 86.8% of the dental surgeons' (p=0.015).

Conclusions: Level of communication between dentists and dental technicians is inadequate. A significant proportion of prescriptions failed to meet the relevant standards. It is recommended that awareness on the importance of correct laboratory prescriptions should be improved for all dental surgeons, undergraduates and technician trainees.

Key words: prosthetic laboratory prescription, lab audit, undergraduates, dental surgeons

Introduction
It is important that dentists and dental technicians are aware and have an understanding of each other's clinical and technical responsibilities and limitations in order to provide quality care for the patient[1-4]. The final outcome of the prosthesis and its success is reliant on the effective communication between the dentist and dental technician.

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Communication between dentists and technicians is primarily through the use of written laboratory prescriptions[5,6]. A dental prosthesis or a dental appliance is fabricated based on the information given in the laboratory prescription. Hence it is essential that it carries all the necessary information clearly which will enable the technician to fabricate the prosthesis as prescribed. Even though this process requires effective teamwork between two groups of the dental team, ultimate responsibility for the final product lies with the clinician[7,8]. Therefore, it is important that the clinician clearly understands the fabrication procedure, material science including material selection and design principles[2]. A clinician should also be able to critically assess the jobs sent by the dental laboratory since an error made at one stage will be continued with subsequent stages and finally will affect the outcome of the end product. Thus, clinician or the dentist bears the primary responsibility to deliver clear and accurate prosthetic prescriptions to the technician and ensure that he gets what he has requested. On the other hand, the dental technician is responsible to fabricate the dental prosthesis or the dental appliance as per the instructions specified in the laboratory prescription[2,9,10]. Nonadherence to the prescription will lead to an unacceptable prosthesis or an appliance. Moreover, if the instructions are not clear, incomplete, or difficult to understand, the outcome will be affected[5,10,11]. In the instances where decision making is left to the technical officer, the outcome cannot be always guaranteed. Even though a technician who is knowledgeable and having more experience and the skill is able to undertake such responsibilities, same cannot be expected with a novice. Thus, complete and clear prescriptions prescribed by the clinician are always recommended to ensure quality. On the other hand, when the technician encounters a problem with the prescription or if he cannot comprehend what is written in the prescription, he should be encouraged to clarify the matter before proceeding. Two way communication would save time and cost involved in re-fabrication.

When planning and implementing curricula it is important to consider these aspects and ensure both the dental graduates and the auxiliaries possess the knowledge and attitudes required for such practice.

Assessing the quality of prosthetic prescriptions for adequacy and clarity is therefore important to ensure success of the prosthetic care. To best of our knowledge such an audit has not been undertaken previously in Sri Lanka. Since this audit had been carried out at the Faculty of Dental Sciences where Bachelor of Dental Surgery (BDS) and Higher Diploma in Dental Technology (HDDT) are offered, our objectives were to assess the quality of prosthetic lab prescriptions written by the qualified dental surgeons and undergraduate and to make recommendation when developing and implementing the undergraduate and dental technology curricula. Moreover it would enable to modify existing practice and laboratory prescription form, increasing awareness of students on good lab prescription writing and ultimately will improve the care provided for the patient.

Materials and Methods
All prescriptions sent to the prosthetic lab for the fabrication of complete and partial dentures at the Department of Prosthetic dentistry, Faculty of Dental Sciences, University of Peradeniya from the beginning of 2017 until the end of 2019 were audited. Prescriptions sent for the fabrication of maxillofacial prosthesis and other appliances were not considered as they are not undertaken by the dental undergraduates. The sample consisted of 2000 laboratory prescriptions written by the undergraduates and qualified dental surgeons including consultants, house officers and postgraduate students. The investigation aimed to discover the nature of prescriptions and information was sought regarding the completeness of essential information and the quality of written instructions by the undergraduates and qualified dental surgeons.

Front page of the prescription form required to be filled with the essential information of the patient, operator and the technical officer. Other details with regard to the job which needed to be filled or ticked were prescription date, the fact that it was disinfected or not, the date of arrival, due date and the date finished which had to be completed for each stage of denture fabrication. The prescription form for the partial dentures had a diagram of maxillary and mandibular arches which can be used to draw the denture design and indicate the position of the clasps. (Figure-1) Back side of the prescription form consisted of three columns indicating the date, prescription and the signature. Operator can utilize this space for writing the prescription for each stage and authorize it by placing the signature.

Information was collected under two headings.
> Essential information
> Quality of the written instructions

Under essential information, important features of the prescriptions such as details of the prescribing dentist (name, student's ID number), signature of dentist or supervisor, date of submission to the laboratory, due date / next appointment date, required oral prosthesis or appliance were assessed. In addition, details of the patient (name, registration number, address, contact number) were sought for.

Under the quality of the written instructions, features such as; materials for casts, trays and record bases, features of custom tray design, tooth

Figure 1. Laboratory prescription form

Guidelines set forth by the Medical and Healthcare Products Regulatory Agency (MHRA) of the European Union was utilized as a guide for the audit.[12] According to MHRA, ten specific pieces of information needed to be present on a prosthetic prescription.[13]

shade and mould and denture design features such as addition of clasps and post dam were looked for. The presence or absence of each information and instruction was recorded and compared for complete and partial dentures separately between the undergraduates and qualified dental surgeons.

All instructions given for each stage of complete denture construction namely: (instructions to construct the primary cast, primary cast material, special tray type, special tray material, secondary cast, material for the secondary cast, record block, materials for the record block, the trial denture, selected tooth shade, mould and addition of post dam) were noted to be present or not present in the prescription.

For the presence of an instruction, a value of 2 was assigned and a value of 1 was assigned for absence. Score for all 12 items were summed up and depending on the final score; prescriptions were classified as follows;

1. Clear-A score of 24 (instructions are clear with all necessary information to the technician been provided.)
2. A guide only-A score of 19-23 (minor decision making has been left to the technician.)
3. Poor -A score of 18 or below (major decision making has been left to the technician.)

All the prescriptions were compared between the two professional levels. This allowed careful comparison of the standards of written instructions and non-compliant prescriptions between the two professional levels.

Statistical Analysis
The data collected was recorded and analysed using Microsoft Excel spread sheet. Descriptive statistics were carried out and the Chi square test was used to test for associations between variables. Significance was calculated at the level of p value less than 0.05 (p<0.05).

Results
Out of two thousand laboratory prescriptions, 1474 (73.7%) were prescribed by the undergraduates while 525 (26.3%) prescriptions were from qualified dental surgeons. Out of the 2000 patients, 1628 (81.4%) patients were provided with both upper and lower dentures while 373 (8.6%) were provided with an upper or a lower denture, leading to a total of 3629 dentures. Table-1 summarizes the number of dentures that were delivered from 2017 to 2019.

Essential Information
Out of the undergraduates, 96.2% provided their name in the prescription form while only 78.5% of the qualified dental surgeons provided their name. The observed difference was not statistically significant (p>0.05). Every detail regarding the patient such as, name, registration no, address, and contact number, was present in 66.7% of the qualified dental surgeons and 70% of the students, which was not statistically significant (p>0.05).

When considering the essential details in the prescription, all students and qualified dental surgeons provided the patients name, patients' registration number, dates of prescription, due dates and signature in the prescription form.

Quality of the Written Instructions
When comparing the laboratory prescriptions written for complete dentures, the prescriptions written by undergraduate students were clearer (with all instructions and information) than the qualified dental surgeons. Clear prescriptions were significantly higher among students (p=0.0005). (Table-2)

Table 1. Summary of the types of dentures provided

	Complete Dentures	Partial Dentures	Total
Upper	640 (34.6%)	1209 (65.4%)	1849
Lower	591 (33.2%)	1189 (66.8%)	1780
Total	1231	2398	3629

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Table 2. The standards of prescriptions

	Clear	Only a guide	Poor	Total
Dental Surgeons	6 (5.2%)	68 (58.6%)	42 (36.2%)	116
Students	41 (7.8%)	470 (89.8%)	12 (2.2%)	523
Total	47	538	54	639

Prescribing the Material

Undergraduate students prescribed the materials for the casts, special trays and record blocks than the qualified dental surgeons. Special tray material was included in the prescriptions significantly by the undergraduate students (p<0.05). Table-3 summarizes the number of prescriptions with the cast, special tray and record block materials.

Prescriptions written by undergraduate students contained clear and complete instructions about special tray and record block construction. Both type and the material to be used in construction of the special tray were mentioned in 86.8% of the qualified dental surgeons' and 93.8% of the students' prescriptions. This difference was statistically significant. (p=0.015).

The instructions to construct the record block with clear instructions about the material were present in 38.7% of the students' prescriptions and 28.2%

of the prescriptions by qualified dental surgeons. The instructions to construct the record block without mentioning the material was present in 68% of the dental surgeons' prescriptions and 59.8% of the students' prescriptions. The clarity of students' instructions was significantly higher than the qualified dental surgeons (p=0.0003). (Table-4)

Other Design Features

Other denture designing information such as tooth shade, mould and clasp position were provided in students' prescriptions than the qualified dental surgeons. Providing the clasp position was significantly higher in prescriptions by students. (p=0.0002). However, the instructions to add the post dam were mentioned in dental surgeons' prescriptions than the undergraduate students which were statistically not significant. Table 5 summarizes the other instructions on denture designing.

Table 3. The percentages of laboratory prescriptions with the dental materials

Material	Qualified dental surgeons	Students	P value
Primary cast material	41%	90.5%	2.3
Special tray material	97.8%	99.1%	0.04
Secondary cast material	36.8%	81.1%	1.03
Record block material	30.8%	59.9%	5.22

Table 4. Information on special trays and record blocks

	Information on special trays			Information on record blocks		
	Both information	Only one information	P value	Both information	Only one information	P value
Dental Surgeons	237(86.8%)	36(13.1%)		113(28.1%)	273(68.1%)	
Undergraduate students	1041(93.8%)	68 (6.1%)	0.015	497 (38.3%)	767 (59.8%)	0.00013
Total	1278	104		610	1040	

Table 5. Information written on denture designing by undergraduates and dental surgeons

	Percentage of prescriptions that provided the information		
	Qualified dental surgeons	**Undergraduate students**	**P value**
Tooth shade	95.4	98.5	4.6
Mould of teeth	83.9	96.2	8.0
Clasp position	63.6	73.5	0.0002
Addition of post dam	32	31	0.844

Discussion

Laboratory based audits have been considered as an important component in health care and dental education. It has been identified that an audit of this nature is demanding of dental surgeons and students' time but does show where improvements can be made in patient management which will result in improved health care[14]. Previous research has shown the quality of prosthetic prescriptions is inadequate or non-compliant and failed to meet standards recommended by regulating bodies[5,15]. In our study too only7.8%of the students' and 5.2% of the qualified dental surgeons' prescriptions could be considered as complete and clear while majority of the prescriptions belonged to middle category where some amount of decision making had been left to the technical officer.

As the laboratory prescription form serves as a concise account compared to patient's folder as to what has been carried out for a particular patient, it should be a complete one. However duplication of information can be one reason for incomplete prescriptions. Previous research has identified drawing the denture design on the cast as a possible cause for not drawing the design in the prescription[1,13,16]. Practices exclusive for an institution can also lead to misjudgment with audits. In the institution where this audit had been carried out, it is the routine practice to prescribe the material to pour primary and secondary impression in a small tag placed on the impression. This could be one reason for not specifying that in the prescription form as the instruction had already been given. However, as

the tag cannot be retrieved, that instruction will not be recorded. While duplication of records is desirable for convenience, the importance of complete record keeping should be emphasized.

Although previous research has recommended the inclusion of prosthetic prescription writing module in dental curricula[2,5,9] these have not been adhered to[7,13,15]. In our institution also it is the same and there is not a separate prosthetic prescription writing module across the ten semesters in the undergraduate curriculum. However, an extensive Dental Laboratory Technology (DLT) course is included with 5 credit values where dental undergraduates spend 30 hours to learn and practice dental laboratory technology in removable prosthodontics. They are taught all the stages in removable prosthodontics via lectures, live demonstrations and procedural videos produced by the department. In addition, they do hands on practice up to the try in stage of complete denture fabrication. Therefore it is assumed that the dental undergraduates are knowledgeable regarding the choice of material and design features and possess required practical skills to carry out and assess various laboratory procedures pertaining to fabrication of removable prosthodontics. Their competencies are assessed both during in-course assessments and end semester assessments. Various means of assessments are utilized including practical tests, objective structured practical examinations (OSPEs) and objective structured clinical examinations (OSCEs). Ability to write a prosthetic prescription for a given denture design is assessed with OSPE for dental undergraduates.

On the other hand, the trainee dental technicians are taught all the clinical and laboratory stages involved in removable prosthodontics with the use of PowerPoint presentations in DT 2103 course. The lectures also emphasize how the clinical work can affect the laboratory outcome and the importance of effective communication. Moreover, they are taught to interpret prosthetic prescriptions in DT 2203 course. Therefore, it is apparent that both groups of students are taught how to complement each other's work in order to achieve a successful prosthetic outcome at the end. However, if the skill of prosthetic prescription writing is not spelled out as a credited Intended Learning Outcome (ILO), it is unlikely that the students will be keen to learn it. Chances are high that it would be missed in assessments when making the blueprint. Therefore it is highly recommended that the prosthetic prescription writing be included in the course content under DLT. Similarly interpreting prosthetic laboratory prescriptions should be an ILO in Diploma in Dental Technology curriculum. Both the qualified dental surgeons and technical officers should be updated on importance of writing clear complete lab prescriptions and to interpret them accurately. A study done in Australia has revealed that 85 percent of the prosthetic lab prescriptions did not comply with the recommended conventions. However, it has improved to 30 percent of the total after the education intervention on writing good prescriptions. Therefore, they have suggested that there is an advantage in including a prosthetic prescription-writing module in dental school curricula[13].

It has also been noted certain important items of the prescription form is seldom utilized. The fact whether the job is disinfected or not is rarely indicated which is an issue needing instant follow up remedies at a time where infection control procedures are so critical. Even though in column indicating the date lab has received the job is sometimes filled, out column indicating finished date is rarely filled. This leads to delays in arranging patients' appointments and hampers

the procedures of routine checkups prior to the arrival of the patient as the cases are handed over at the last minute. It is recommended that all the cases are finished and be ready at least one day prior to due date in order to accomplish this.

Conclusion

It can be concluded that the level of communication between dentists and dental technicians, even within a close working environment, can at times be inadequate. It was evident that a significant proportion of prescriptions were non-compliant and failed to meet the relevant standards. It can be recommended that awareness on the importance of correct laboratory prescriptions should be improved for all dental undergraduates and dental technician trainees. Dental surgeons should be updated on the importance of writing a complete lab prescription form in continuous study programs. It would also be prudent to keep a copy of the guidelines for lab prescriptions available in the clinic for reference.

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One article per issue may be published on a current topic of interest, one's expertise or commentaries of general practice etc. These articles are commissioned by the Editors and may be considered at the Editors' discretion. They should not exceed 2500 words (excluding the abstract and references) and 20 references.

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The introduction should carry sufficient background information on the subject of study.

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This should state clearly the main conclusions and provide an explanation of the importance and relevance of the study reported.

Acknowledgements

The source of financial grants and other funding should be acknowledged, including a frank declaration of the authors' industrial links and affiliations. The contribution of colleagues or institutions should also be acknowledged.

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Tables should be self-contained and complement, but not duplicate, information contained in the text. Tables should be numbered consecutively in Arabic numerals. Each table should be presented on a separate sheet with a comprehensive but concise title above the table. Tables should be double-spaced and vertical lines should not be used to separate columns. There should be no left & right borders and no/ minimum internal horizontal lines to separate rows. Column headings should be brief, with units of measurement in parentheses; all abbreviations should be defined in footnotes. Footnotes to tables should be indicated by superscript lowercase letters (or asterisks for significance values and other statistical data) and included beneath the table body. Statistical measures such as SD or SEM should be identified in the headings. The table and its title/footnotes should be understandable without reference to the text.

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1979; 37(6): 407-9.

Electronic journal article
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