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Oral Care Management of Head and Neck Cancer Patients at Hospital Universiti Sains Malaysia: A 7-Year Retrospective StudyHuikai Chew^a, Kasmawati Mokhtar^{a*}, Yew Hin Beh^{a,b},
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ABSTRACT

Head and neck cancer patients require oral assessment and management prior, during and after cancer treatment to minimise oral complications. Hence, this study aimed to evaluate sociodemographic data, oral health management, oral complications derived from cancer treatment, time frame in completing dental treatment and association between oral management and complications. Purposive record sampling of head and neck cancer patients who completed radiotherapy and/or chemotherapy at Hospital Universiti Sains Malaysia (HUSM) from 2011 to 2017 were reviewed. A checklist was used to record the data and analysed using descriptive statistics and Pearson Chi-square test. A number of 194 patient records were reviewed with majority were Malays (88.1%), males (61.3%) with the mean age of 57.18 years old. Only 21% of the patients had oral assessment prior to cancer treatment. About 84% of the referred patients were dentally fit within 1 month. Mucositis and fungal infections were the most prevalent complications. The relationship between oral assessment prior to cancer treatment and oral complications was not significant ($p = 0.134$). Despite the insignificant association due to several limitations, oral assessment and management prior, during and after cancer therapy are recognised as crucial for improving quality of life. A standard institutional operating procedure is recommended to improve patient care.

Keywords: Chemotherapy; head and neck cancer; oral complication; oral management; radiation therapy

INTRODUCTION

Head and neck cancer is a group of cancers that originates in the mouth, nose, throat, larynx, sinuses or salivary glands. Experiencing a voice change, having a lump or sore that does not heal, difficulties in swallowing or a persistent sore throat are

among the symptoms for head and neck cancer. Other possible symptoms may include breathing difficulties, unusual bleeding or facial swelling.

Moreover, patients may be asymptomatic until the cancer becomes quite advanced and may not experience the usual or obvious

symptoms. Early interventions, particularly expeditious diagnosis and treatment will have a direct effect on the outcomes of the patients (Roser *et al.*, 2015). Therefore, it is of great significance in treatment planning to first identify the stage the patient is in the course of diagnosis and treatment and the type of treatment modality used.

These types of cancers often treated with radiotherapy utilising ionising radiation and semi-selectively damaging the genetic material of vulnerable malignant cells directly or through the production of free radicals result in cell death that produces therapeutic effect (Gupta *et al.*, 2014). In adjunct with radiation therapy, clinicians may also administer chemotherapeutic agents. More favourable results can be achieved by concurrent chemoradiotherapy. However, this method will lead to higher toxicity as compared to using radiotherapy by itself (Machtay *et al.*, 2008).

Since it is not uncommon for head and neck cancer patients to develop oral complications during and after radiotherapy, management of oral health is especially crucial for these patients. Despite the fact that having most of such complications are the inevitable results of deterministic ionising radiation, there are some which can be prevented (Thariat *et al.*, 2012). Some complications that developed are associated with the provided treatment, for instance osteoradionecrosis as a result of dental extractions (Sulaiman *et al.*, 2003; Chang *et al.*, 2007).

It is contended that complications of radiotherapy may result from the same process which causes damage to normal cells, particularly those which divides rapidly or unable to accordingly repair themselves after damage induced by radiation. The clinical manifestation of xerostomia, oral mucositis, dental caries, accelerated periodontal disease, dysgeusia, oral infection, trismus and radiation dermatitis are oral complications of head and neck radiation

therapy resulting from radiation injury to the salivary glands, oral mucosa and taste buds, oral musculature, alveolar bone and skin. Some of these complications are acute and reversible such as mucositis, dysgeusia, oral infections and xerostomia while others are chronic such as xerostomia, dental caries, accelerated periodontal disease, trismus and osteoradionecrosis (Dreizen, 1990). On the other hand, patients treated with multimodality chemotherapy may have their quality of life significantly impaired as they might face a heightened risk of developing oral mucositis and secondary oral infections such as candidiasis (Cooper *et al.*, 1995).

To minimise the oral morbidity of such patients before, during and after cancer treatment and throughout their lifetime, clinicians must meticulously consider any possibilities of oral complications of both radiotherapy and chemotherapy so that every effort is undertaken (Hancock *et al.*, 2003). Since development of oral complications post chemotherapy or radiotherapy is not uncommon, potentially preventable, and possibly arise due to iatrogenic causes, it is crucial that those working with head and neck cancer patients to always be aware of the prevention and management of these effects (Beech *et al.*, 2014). A better management or prevention of such sequelae or complications which will compromise patients' quality of life can only be achieved if both medical and dental health practitioners work hand in hand. Thus, this signifies the importance of acquiring a vast working knowledge of the prevention and management options for the oral sequelae of cancer treatment (Hancock *et al.*, 2003).

Therefore, this study aimed to evaluate sociodemographic data, oral health management, oral complications derived from cancer treatment, time frame in completing dental treatment and association between oral management and complications.

MATERIALS AND METHODS

Study Design

This is a retrospective cross-sectional record review study of head and neck cancer patients who presented to Hospital Universiti Sains Malaysia (HUSM), in a period of seven years, from January 2011 to December 2017. Purposive record sampling of these patients were done at HUSM medical record unit. The inclusion criteria comprised head and neck cancer patients who were Malaysian citizen without any age limit and had undergone or completed cancer therapy at the Nuclear Medicine, Radiotherapy and Oncology Department of HUSM from 2011 to 2017 with evidence of referral to HUSM dental clinic. Any records with missing data were excluded from the study. This study was approved by Human Research Ethics Committee of Universiti Sains Malaysia (ethical approval number: USM/JEPeM/19010039).

A structured checklist for oral care management on head and neck cancer patients was used for documentation of information from the patients' folders. The checklist contained six different parts comprising the following variables:

- (1) Sociodemographic data;
- (2) Details of the cancer diagnosed which includes the type of head and neck cancer, staging, date diagnosed and the types of therapy received;
- (3) Details of dental management which includes referral and appointment dates, treatment planning and procedures done during dental visit;
- (4) Oral evaluation of the patient prior to oncology therapy which includes clinical and radiographic examination;
- (5) Oral management of the patient prior to and after oncology therapy;
- (6) Oral complications that arise following oncology therapy and their management.

Clinical records of head and neck cancer patients who fulfilled the inclusion criteria were reviewed to complete the checklist prepared. All data were kept private for privacy protection and confidentiality of the patients.

Statistical Analysis

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) software 25.0 (IBM, Armonk, NY, USA). Data were collected, analysed and presented using descriptive statistics through mean and frequency analysis to tabulate the sociodemographic data, types of oral health management, oral complications that arise following cancer treatment and time taken to complete dental treatment. Pearson Chi-square test was used to determine the association between oral assessment prior to cancer treatment and oral complications that arise following the treatment. The result of this association was considered significant if *p*-value is less than 0.05.

RESULTS

A total record of 194 head and neck cancer patients were retrieved. Table 1 shows the sociodemographic background of the patients. Among the patients, majority were males (61.3%) and Malays (88.1%). The mean age of the patients was 57.18 years old. The most dominant types of head and neck cancer were oral and oropharyngeal cancer (42.3%) and nasopharyngeal cancer (34%).

Table 2 shows that there were only 21% (*n* = 41) of the patients who had oral assessment prior to cancer treatment. Out of this, 25 patients were referred by other departments such as oncology, otorhinolaryngology and medical to the dental clinic while another 16 patients presented to dental clinic with dental problems before being diagnosed with cancer. All these referred patients had their first dental appointment within one week

and majority (84%) had their treatment completed within one month of referral (Fig. 1).

Out of the patients who had oral management prior to oncology therapy, 21 of them had scaling and prophylaxis, 17 had tooth extraction and 16 received

oral hygiene instructions (Fig. 2). Other treatments provided include restoration of carious lesions, professionally applied topical fluoride, replacement of ill-fitting denture, minor oral surgery, removal of prosthesis, advice on soft food diet and the use of mouthwash.

Table 1 Sociodemographic characteristics and clinical background data of head and neck cancer patients who underwent radiotherapy ($n = 194$)

Variables	Mean (SD)	Frequency (%) ($n = 194$)
Age	57.18 (16.368)	
Sex		
Male		119 (61.35)
Female		75 (38.70)
Ethnic		
Malay		171 (88.10)
Chinese		18 (9.30)
Indian		2 (1.00)
Others		3 (1.50)
Referred from elsewhere		
Yes		123 (63.40)
No		71 (36.60)
Type		
Laryngeal and hypolaryngeal		4 (2.10)
Nasal cavity and paranasal sinus		7 (3.60)
Nasopharyngeal		66 (34.00)
Oral and oropharyngeal		82 (42.30)
Salivary gland		35 (18.00)
Stage		
I		8 (4.10)
II		19 (9.80)
III		28 (14.40)
IVA		51 (26.30)
IVB		24 (12.30)
IVC		32 (16.50)
Unknown		32 (16.50)

Table 2 Relationship between oral management prior to cancer treatment and oral complications

Oral management prior to cancer treatment	Oral complication(s)		Total	χ^2 (df)	<i>p</i> -value*
	Yes	No			
Yes	15	26	41 (21%)	2.248 (1)	0.134
No	38	115	153 (79%)		
Total	53 (27%)	141 (73%)	194 (100%)		

Note: *Chi-square test with significance level set at $p < 0.05$

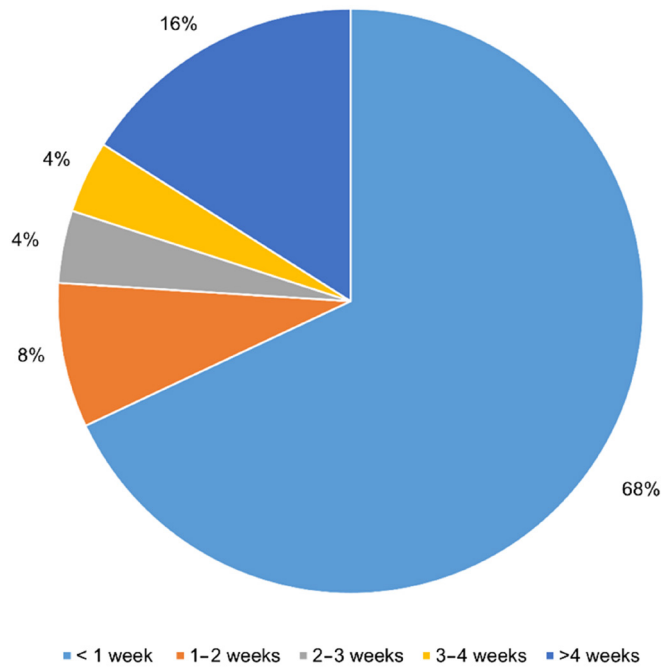


Fig. 1 Time taken for patients to complete dental treatment ($n = 25$).

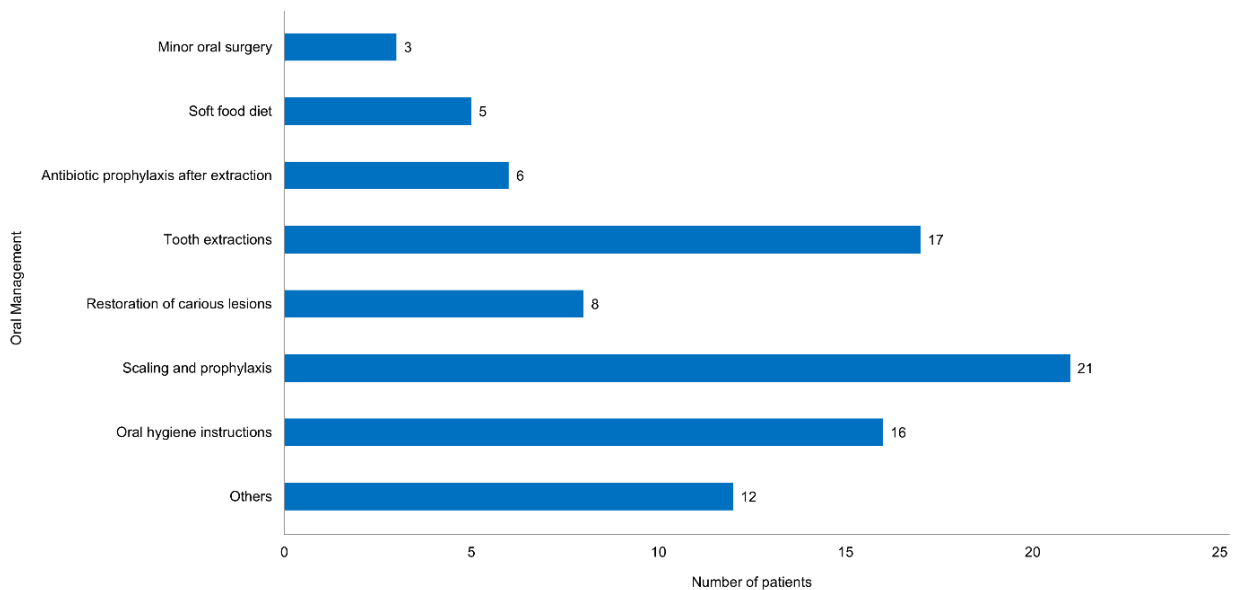


Fig. 2 Oral management prior to oncology therapy.

In this study, 53 patients developed oral complications during oncology therapy, with some developing multiple complications (Table 2). The most prominent oral complication was oral mucositis ($n = 38$) (Fig. 3). Sodium bicarbonate mouthwash was the main prescription given to these patients, while other prescription included

Diffiam[®] gargle, Lignocaine viscous gargle, Thymol[®] gargle, Benzocaine solution, Oral7[®] mouthwash, magic mouthwash (contains diphenhydramine 0.075%, hydrocortisone 0.125, nystatin 7500 μ /ml and lidocaine 0.4%), DF118 Forte[®] and Bonjela[®]. The second most common complication was fungal infection ($n = 17$) for which all

patients were prescribed with nystatin/ amphotericin suspension. The third most complication that occurred was xerostomia ($n = 9$) for which most patients were prescribed with artificial saliva while the others were advised to increase oral fluid intake and gum chewing.

The next most common complications were trismus and bacterial infection ($n = 5$). For trismus, prescribed management include physiotherapy exercises, analgesics and anti-inflammatory medications. For bacterial infection, prescribed treatments

include extraction for odontogenic infection, parenteral antibiotics for gingival infection and intravenous antibiotics for mucosal infections. Other complications ($n = 8$) which arose included osteoradionecrosis, dysphagia, periodontal problems and dental caries.

It was recorded that nine patients received oral management post-oncology therapy (Fig. 4). The types of management provided included oral hygiene instructions ($n = 7$), scaling and prophylaxis ($n = 5$), dental follow-up and monitoring ($n = 4$) and

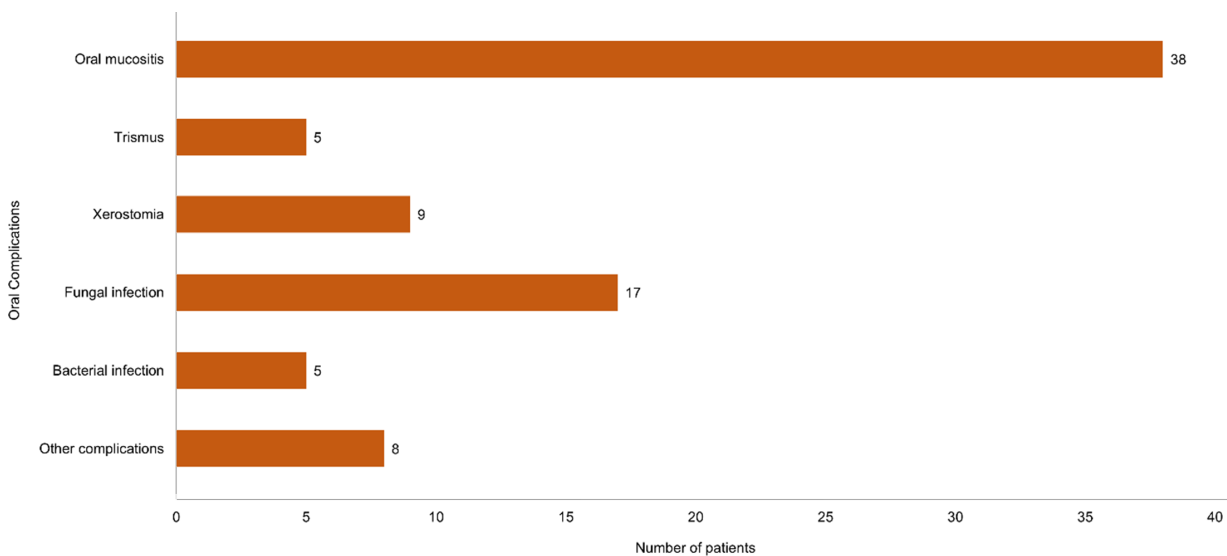


Fig. 3 Types of oral complications which arises during oncology therapy.

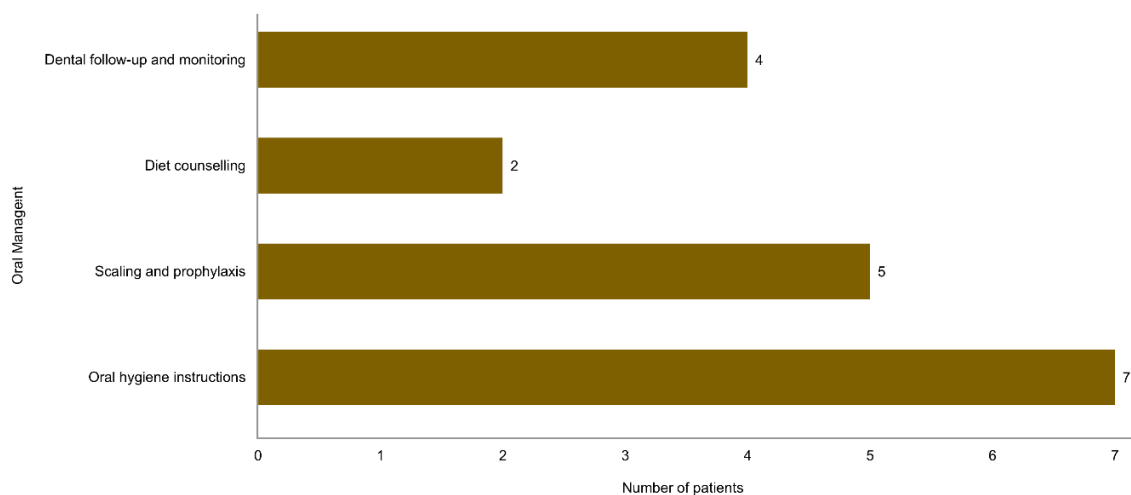


Fig. 4 Oral management after oncology therapy.

diet counselling ($n = 2$). A non-significant relationship was obtained between oral assessment prior to cancer treatment and oral complications ($p = 0.134$).

DISCUSSION

Several guideline review articles are available to guide dental practitioners in managing the oral conditions for patients requiring oncological treatments and its related long-term follow-up (NICE, 2004; AAPD, 2013; Kumar *et al.*, 2013; Jawad *et al.*, 2015a; Jawad *et al.*, 2015b; Pouloupoulos *et al.*, 2017). Some disease specific guidelines related to oral complications secondary to oncological therapy are also available (Ruggiero *et al.*, 2006; Lalla *et al.*, 2014). However, there is no clinical practice guideline available in dental management of patients receiving cancer therapy in Malaysia.

Hence, this study serves as an overview on how patients receiving cancer treatment are managed in terms of oral health in this institution. To the best of our knowledge, there is no study in this area conducted in Malaysian dental practice. HUSM is the main referral centre in the east coast of Malaysia in which it receives majority of referrals for advance management and treatment of malignancy which include head and neck cancer.

Head and neck cancer predominantly diagnosed in males (Bhattacharjee *et al.*, 2006; MacCarthy *et al.*, 2017) and is consistent in our study in which 61.3% are male patients while 38.7% are females. According to the American Society of Clinical Oncology (ASCO), there are five main types of head and neck cancer, each named according to the primary tumour site. These include laryngeal and hypopharyngeal cancer, nasal cavity and paranasal sinus cancer, nasopharyngeal cancer, oral and oropharyngeal cancer and salivary cancer with incidences of 2.1%, 3.6%, 34%, 42.3% and 18% as reported in this study.

This study showed only 21% ($n = 41$) of those patients received dental assessment prior to oncology treatment. This number is much lower compared to studies by Lawrence *et al.* (2013) and MacCarthy *et al.* (2017) whereby up to 52% and 79% of patients in the particular hospital had assessment by dental practitioner prior to cancer treatment, respectively. However, based on National Head and Neck Cancer Audit 2014 reported by National Health Service England, it showed that only 35.2% had pre-cancer treatment dental assessment. The limitation of our methodology probably contributed to the lower percentage yield. Due to the fact that some of our patients coming from distant locations and may require to travel up to hours to attend to our facility hence, a number of patients may prefer to have dental assessment and treatment done at their proximity (McGuire, 2003). In addition, local patients are free to choose to have dental treatment done at private facility. Clinical records are our only source of knowing whether the patient had any dental assessment, and these records only provide information on treatments done at HUSM, hence limited information is obtained. Lawrence *et al.* (2013) conducted their study based on telephone call and face-to-face interview, but they may be influenced by poor response rate while MacCarthy *et al.* (2017) employed a retrospective, observational audit in their study. Seemingly, this is a worldwide issue to get all patients subjected to oncological treatment to have dental assessment prior to cancer treatment as the standard of care.

In this study, all patients referred by other departments to the dental clinic obtained their first dental appointment within one week and majority (84%) of the referred patient completed their treatment within one month of referral. Ideally, each patient should be dentally fit at least 7–10 days prior to initiation of oncological treatment to allow adequate healing period (Walsh, 2010; Beech *et al.*, 2014). Adherence to personalised systematic oral hygiene and preventive

protocol may reduce the occurrence, severity and duration of oral complications arose from radiotherapy or chemotherapy and eventually preventing alterations of optimal oncological therapeutic course and improved patients' survival throughout the course of treatment (Walsh, 2010; Epstein *et al.*, 2014). Those patients who were assessed by dental practitioner in our dental clinics had oral hygiene instructions and diet counselling delivered.

Mucositis occurred in approximately 20% to 40% of patients receiving conventional chemotherapy, 80% of patients receiving high-dose chemotherapy as conditioning for hematopoietic stem cell transplantation and nearly all patients receiving head and neck radiotherapy (Jones *et al.*, 2006; Vera-Llonch *et al.*, 2006; Vera-Llonch *et al.*, 2007). In our study, 20% of patients had oral mucositis during cancer treatment and it is consistent to the reported incidence. Management of mucositis are targeted to improve oral hygiene, improve hydration and to reduce pain (Kumar *et al.*, 2013). Other novel therapeutic techniques are yet to be proven as more beneficial compared to conventional sodium bicarbonate mouth rinses (Walsh, 2010; Kumar *et al.*, 2013).

Salivary glands, especially the parotid gland may be damaged by radiation leading to hyposalivation and increased salivary viscosity experienced as xerostomia (Beech *et al.*, 2014). Xerostomia affects speech and taste, chewing and swallowing difficulties, increases the risk of developing oral infections such as candidiasis, gingivitis, acute suppurative sialadenitis and also caries (Porter *et al.*, 2010). There were 5% of patients in HUSM who experienced xerostomia during the cancer treatment. A number of methods that were proposed to reduce xerostomia, such as amifostine, intra-glandular botulinum therapy and alpha-tocopherol however the desired effects are unpredictable (Porter *et al.*, 2010; Beech *et al.*, 2014). Currently, systemic treatments for the prevention of xerostomia

are only used in a research setting (Porter *et al.*, 2010). About 66.7% of patients with xerostomia in our study were managed by artificial saliva. For many patients, the only option is saliva replacement (Kumar *et al.*, 2013).

It is well documented that patients undergoing chemotherapy or radiotherapy have an increased risk of oral fungal infection (Lalla *et al.*, 2010). Nine percent of head and neck cancer patients in HUSM had fungal infection during their cancer treatment. Antifungal medication is the treatment of choice besides maintaining good oral hygiene (Lalla *et al.*, 2010; Pappas *et al.*, 2016). Due to the reduced side effects, topical agent is preferable (Bensadoun *et al.*, 2011). However, there are inconsistent efficacy of topical agents and advice that systemic antifungal agents are preferred by some oncology centres and the risk of each patient should be identified before they are being prescribed (Lalla *et al.*, 2010). In our study, all our patients were prescribed with nystatin oral suspension as recommended (Lalla *et al.*, 2010; Pappas *et al.*, 2016). Denture hygiene is essential for denture wearer, and it should be cleaned frequently with tooth brush and soaked in chlorhexidine mouthwash or diluted sodium hypochlorite (Webb *et al.*, 1998) and keeping the denture dry (Stafford *et al.*, 1986).

The most severe potential complication of bone irradiation is osteoradionecrosis (Marx & Johnson, 1987; McLeod *et al.*, 2012). Based on this study, there was one patient who developed osteoradionecrosis which is lower than that of reported incidence of 5%–15% (Costantino *et al.*, 1995; Thorn *et al.*, 2000; Epstein *et al.*, 2001). This is mostly due to the inadequate observational time as this is a long-term complication of radiation associated with procedures related to alveolar bone manipulation and ill-fitting denture (Walsh, 2010; Silvestre-Rangil & Silvestre, 2011). There is no universally accepted treatment of choice to date.

After cancer therapy, a long-term management and close follow-up of patients are imperative yet tends to be ignored. This is paramount to facilitate the management of any chronic complications and detection of any possible tumour recurrence (Hancock *et al.*, 2003). Chemical and microbial changes in the oral cavity following radiation may result in a cariogenic environment (Kielbassa *et al.*, 2006). More than 50% of the patients will demonstrate dental deterioration over time with an incidence risk of 6% per month (Walker *et al.*, 2011). Hence, they are identified as high caries risk group (Pitts *et al.*, 2014). It was noted in our review that limited number of patients were not under long term care which may be due to patients' commitment to medical care which was recognised to be more important, poor motivational support from dental staff and poor awareness between patient and healthcare providers. Only 4.6% ($n = 9$) of our patients had management done post oncological therapy.

There was no statistically significant correlation found between oral health management prior to cancer treatment and complications that arise following cancer therapy ($p = 0.134$). This may be due to the limitations of Chi-square test which includes sample size requirements (McHugh, 2013) as well as missing information in the clinical records. An inclusion of more samples and longer period of observation may improve the outcome of the statistical result as oral complications in the long term is still possible hence appeared to be under reported in our study. There were limited published data related to this association. Despite of that, the role of pre-dental assessment and its management shall not be underemphasised. Optimised oral health before and throughout cancer therapy regarded as the "best care and practice" which significantly prevent interruption of cancer treatment which eventually improved treatment success and overall quality of life (Kumar *et al.*, 2013; MacCarthy *et al.*, 2017). Nevertheless, this level of care should be extended to as long-term care.

A multidisciplinary team (MDT) approach in managing head and neck cancer patient is the best whenever possible and this team consists of oral and maxillofacial surgeon, otorhinolaryngology specialist, oncologist, radiologist, pathologist, restorative specialist, oncological nurses, speech and language therapist, dietitian, general medical and dental practitioners (Lawrence *et al.*, 2013; Epstein *et al.*, 2014; Jawad *et al.*, 2015a). Each member plays his role in assessment, therapy, and long-term maintenance of the patient not only during the active treatment phase but also oral rehabilitations and maintenance after active treatments (Kumar *et al.*, 2013; Beech *et al.*, 2014). However, MDT in HUSM in managing head and neck cancer patients were established with only otorhinolaryngology specialist, clinical oncologist, nuclear medicine specialist and oral maxillofacial surgeons. It was recognised that limited involvement of other sub-speciality such as radiologist, pathologist and dietitian which probably due to timing and resources, complicating the formation of a comprehensive MDT (Bradley *et al.*, 2005). Logbook approach was shown to improve patients' care and allows better communications among practitioners of various disciplines whereby patients' information was disclosed in the logbook (van Wersch *et al.*, 1997). A single standardised logbook used for all health care institutions in Malaysia would have a better impact in terms of patients' care and possibly as a database for future research. An exact example is the use of maternal health record book and neonatal and adolescent health record book which become a standard of care utilised by Ministry of Health Malaysia and being utilised for all healthcare facilities in Malaysia.

CONCLUSION

Despite the insignificant statistical value in this study due to certain limitations, oral assessment and management prior, during and after cancer therapy were recognised as crucial for improving long term quality of life

and thus, all practitioners should be trained in this area. A standard operating procedure on institutional basis is recommended for an improved patient care.

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REFERENCES

- American Academy of Pediatric Dentistry (AAPD) (2013). Guideline on dental management of pediatric patients receiving chemotherapy, hematopoietic cell transplantation, and/or radiation. *Pediatr Dent*, **35**(5): E185–E193.
- Beech N, Robinson S, Porceddu S, Batstone M (2014). Dental management of patients irradiated for head and neck cancer. *Aust Dent J*, **59**(1): 20–28. <https://doi.org/10.1111/adj.12134>
- Bensadoun RJ, Patton LL, Lalla RV, Epstein JB (2011). Oropharyngeal candidiasis in head and neck cancer patients treated with radiation: Update 2011. *Support Care Cancer*, **19**(6): 737–744. <https://doi.org/10.1007/s00520-011-1154-4>
- Bhattacharjee A, Chakraborty A, Purkaystha P (2006). Prevalence of head and neck cancers in the north east—An institutional study. *Indian J Otolaryngol Head Neck Surg*, **58**(1): 15–19. <https://doi.org/10.1007/BF02907731>
- Bradley PJ, Zutshi B, Nutting CM (2005). An audit of clinical resources available for the care of head and neck cancer patients in England. *J Laryngol Otol*, **119**(8): 620–626. <https://doi.org/10.1258/0022215054516214>
- Chang DT, Sandow PR, Morris CG, Hollander R, Scarborough L, Amdur RJ *et al.* (2007). Do pre-irradiation dental extractions reduce the risk of osteoradionecrosis of the mandible? *Head Neck*, **29**(6): 528–536. <https://doi.org/10.1002/hed.20538>
- Cooper JS, Fu K, Marks J, Silverman S (1995). Late effects of radiation therapy in the head and neck region. *Int J Radiat Oncol Biol Phys*, **31**(5): 1141–1164. [https://doi.org/10.1016/0360-3016\(94\)00421-G](https://doi.org/10.1016/0360-3016(94)00421-G)
- Costantino PD, Friedman CD, Steinberg MJ (1995). Irradiated bone and its management. *Otolaryngol Clin North Am*, **28**(5): 1021–1038.
- Dreizen S (1990). Oral complications of cancer therapies. Description and incidence of oral complications. *NCI Monogr*, **9**: 11–15.
- Epstein JB, Güneri P, Barasch A (2014). Appropriate and necessary oral care for people with cancer: Guidance to obtain the right oral and dental care at the right time. *Support Care Cancer*, **22**(7): 1981–1988. <https://doi.org/10.1007/s00520-014-2228-x>
- Epstein JB, Silverman S Jr, Paggiarino DA, Crockett S, Schubert MM, Senzer NN *et al.* (2001). Benzylamine HCl for prophylaxis of radiation-induced oral mucositis: Results from a multicenter, randomized, double-blind, placebo-controlled clinical trial. *Cancer*, **92**(4): 875–885. [https://doi.org/10.1002/1097-0142\(20010815\)92:4<875::aid-cnrc1396>3.0.co;2-1](https://doi.org/10.1002/1097-0142(20010815)92:4<875::aid-cnrc1396>3.0.co;2-1)
- Gupta S, Kong W, Booth CM, Mackillop WJ (2014). Impact of concomitant chemotherapy on outcomes of radiation therapy for head-and-neck cancer: A population-based study. *Int J Radiat Oncol Biol Phys*, **88**(1): 115–121. <https://doi.org/10.1016/j.ijrobp.2013.09.052>

- Hancock PJ, Epstein JB, Sadler GR (2003). Oral and dental management related to radiation therapy for head and neck cancer. *J Can Dent Assoc*, **69**(9): 585–590.
- Jawad H, Hodson NA, Nixon P (2015a). A review of dental treatment of head and neck cancer patients, before, during and after radiotherapy: Part 1. *Br Dent J*, **218**(2): 65–68. <https://doi.org/10.1038/sj.bdj.2015.28>
- Jawad H, Hodson NA, Nixon P (2015b). A review of dental treatment of head and neck cancer patients, before, during and after radiotherapy: Part 2. *Br Dent J*, **218**(2): 69–74. <https://doi.org/10.1038/sj.bdj.2015.29>
- Jones JA, Avritscher EB, Cooksley CD, Michelet M, Bekele BN, Elting LS (2006). Epidemiology of treatment-associated mucosal injury after treatment with newer regimens for lymphoma, breast, lung, or colorectal cancer. *Support Care Cancer*, **14**(6): 505–515. <https://doi.org/10.1007/s00520-006-0055-4>
- Kielbassa AM, Hinkelbein W, Hellwig E, Meyer-Lückel H (2006). Radiation-related damage to dentition. *Lancet Oncol*, **7**(4): 326–335. [https://doi.org/10.1016/s1470-2045\(06\)70658-1](https://doi.org/10.1016/s1470-2045(06)70658-1)
- Kumar N, Brooke A, Burke M, John R, O'Donnell A, Soldani F (2013). The oral management of oncology patients requiring radiotherapy, chemotherapy and/or bone marrow transplantation. *Fac Dent J*, **4**(4): 200–203. <https://doi.org/10.1308/204268513X13776914744952>
- Lalla RV, Bowen J, Barasch A, Elting L, Epstein J, Keefe DM *et al.* (2014). MASCC/ISOO clinical practice guidelines for the management of mucositis secondary to cancer therapy. *Cancer*, **120**(10): 1453–1461. <https://doi.org/10.1002/cncr.28592>
- Lalla RV, Latortue MC, Hong CH, Ariyawardana A, D'Amato-Palumbo S, Fischer DJ *et al.* (2010). A systematic review of oral fungal infections in patients receiving cancer therapy. *Support Care Cancer*, **18**(8): 985–992. <https://doi.org/10.1007/s00520-010-0892-z>
- Lawrence M, Aleid W, McKechnie A (2013). Access to dental services for head and neck cancer patients. *Br J Oral Maxillofac Surg*, **51**(5): 404–407. <https://doi.org/10.1016/j.bjoms.2012.10.004>
- MacCarthy D, Clarke M, O'Regan M (2017). An audit of the baseline dental status and treatment need of individuals referred to Dublin Dental University Hospital for a pre-radiotherapy dental and oral assessment. *J Ir Dent Assoc*, **63**(5): 269–276.
- Machtay M, Moughan J, Trotti A, Garden AS, Weber RS, Cooper JS *et al.* (2008). Factors associated with severe late toxicity after concurrent chemoradiation for locally advanced head and neck cancer: An RTOG analysis. *J Clin Oncol*, **26**(21): 3582–3589. <https://doi.org/10.1200/JCO.2007.14.8841>
- Marx RE, Johnson RP (1987). Studies in the radiobiology of osteoradionecrosis and their clinical significance. *Oral Surg Oral Med Oral Pathol*, **64**(4): 379–390. [https://doi.org/10.1016/0030-4220\(87\)90136-8](https://doi.org/10.1016/0030-4220(87)90136-8)
- McGuire DB (2003). Barriers and strategies in implementation of oral care standards for cancer patients. *Support Care Cancer*, **11**(7): 435–441. <https://doi.org/10.1007/s00520-003-0466-4>
- McHugh ML (2013). The Chi-square test of independence. *Biochem Med (Zagreb)*, **23**(2): 143–149. <https://doi.org/10.11613/bm.2013.018>

- McLeod NM, Pratt CA, Mellor TK, Brennan PA (2012). Pentoxifylline and tocopherol in the management of patients with osteoradionecrosis, the Portsmouth experience. *Br J Oral Maxillofac Surg*, **50**(1): 41–44. <https://doi.org/10.1016/j.bjoms.2010.11.017>
- National Institute for Clinical Excellence (NICE) (2004). *Guidance on Cancer Services – Improving Outcomes in Head and Neck Cancers – The Manual*. London: NICE.
- Pappas PG, Kauffman CA, Andes DR, Clancy CJ, Marr KA, Ostrosky-Zeichner L *et al.* (2016). Clinical practice guideline for the management of candidiasis: 2016 update by the Infectious Diseases Society of America. *Clin Infect Dis*, **62**(4): e1–e50. <https://doi.org/10.1093/cid/civ933>
- Pitts NB, Ismail AI, Martignon S, Ekstrand K, Douglas GVA, Longbottom C *et al.* (2014). *ICCMS™ Guide for Practitioners and Educators*. London: ICDAS Foundation.
- Porter SR, Fedele S, Habbab KM (2010). Xerostomia in head and neck malignancy. *Oral Oncol*, **46**(6): 460–463. <https://doi.org/10.1016/j.oraloncology.2010.03.008>
- Poulopoulos A, Papadopoulos P, Andreadis D (2017). Chemotherapy: Oral side effects and dental interventions. A review of the literature. *Stomatol Dis Sci*, **1**: 35–49. <https://doi.org/10.20517/2573-0002.2017.03>
- Roser SM, Nelson SR, Chandra SR, Magliocca KR (2015). Head and neck cancer. In: Patton LL, Glick M (eds.), *The ADA Practical Guide to Patients with Medical Conditions*, 2nd edn. Hoboken: Wiley Blackwell, pp. 273–298.
- Ruggiero S, Gralow J, Marx RE, Hoff AO, Schubert MM, Huryn JM *et al.* (2006). Practical guidelines for the prevention, diagnosis, and treatment of osteonecrosis of the jaw in patients with cancer. *J Oncol Pract*, **2**(1): 7–14. <https://doi.org/10.1200/JOP.2006.2.1.7>
- Silvestre-Rangil J, Silvestre FJ (2011). Clinico-therapeutic management of osteoradionecrosis: A literature review and update. *Med Oral Pathol Oral Cir Bucal*, **16**(7): e900–e904. <https://doi.org/10.4317/medoral.17257>
- Stafford GD, Arendorf T, Huggett R (1986). The effect of overnight drying and water immersion on candidal colonization and properties of complete dentures. *J Dent*, **14**(2): 52–56. [https://doi.org/10.1016/0300-5712\(86\)90051-5](https://doi.org/10.1016/0300-5712(86)90051-5)
- Sulaiman F, Huryn JM, Zlotolow IM (2003). Dental extractions in the irradiated head and neck patient: A retrospective analysis of Memorial Sloan-Kettering Cancer Center protocols, criteria, and end results. *J Oral Maxillofac Surg*, **61**(10): 1123–1131. [https://doi.org/10.1016/s0278-2391\(03\)00669-4](https://doi.org/10.1016/s0278-2391(03)00669-4)
- Thariat J, Ramus L, Darcourt V, Marcy PY, Guevara N, Odin G *et al.* (2012). Compliance with fluoride custom trays in irradiated head and neck cancer patients. *Support Care Cancer*, **20**(8): 1811–1814. <https://doi.org/10.1007/s00520-011-1279-5>
- Thorn JJ, Hansen HS, Specht L, Bastholt L (2000). Osteoradionecrosis of the jaws: Clinical characteristics and relation to the field of irradiation. *J Oral Maxillofac Surg*, **58**(10): 1088–1093. <https://doi.org/10.1053/joms.2000.9562>
- van Wersch A, de Boer MF, van der Does E, de Jong P, Knegt P, Meeuwis CA *et al.* (1997). Continuity of information in cancer care: evaluation of a logbook. *Patient Educ Couns*, **31**(3): 223–236. [https://doi.org/10.1016/s0738-3991\(97\)00030-x](https://doi.org/10.1016/s0738-3991(97)00030-x)
- Vera-Llonch M, Oster G, Ford CM, Lu J, Sonis S (2007). Oral mucositis and outcomes of allogeneic hematopoietic stem-cell transplantation in patients with hematologic malignancies. *Support Care Cancer*, **15**(5): 491–496. <https://doi.org/10.1007/s00520-006-0176-9>

- Vera-Llonch M, Oster G, Hagiwara M, Sonis S (2006). Oral mucositis in patients undergoing radiation treatment for head and neck carcinoma. *Cancer*, **106**(2): 329–336. <https://doi.org/10.1002/cncr.21622>
- Walker MP, Wichman B, Cheng AL, Coster J, Williams KB (2011). Impact of radiotherapy dose on dentition breakdown in head and neck cancer patients. *Pract Radiat Oncol*, **1**(3): 142–148. <https://doi.org/10.1016/j.prro.2011.03.003>
- Walsh LJ (2010). Clinical assessment and management of the oral environment in the oncology patient. *Aust Dent J*, **55**(Suppl 1): 66–77. <https://doi.org/10.1111/j.1834-7819.2010.01201.x>
- Webb BC, Thomas CJ, Willcox MD, Harty DW, Knox KW (1998). Candida-associated denture stomatitis. Aetiology and management: A review. Part 3. Treatment of oral candidosis. *Aust Dent J*, **43**(4): 244–249. <https://doi.org/10.1111/j.1834-7819.1998.tb00172.x>