Compendium of Oral Science Volume 9(1)/2022
Original Article

Cost Analysis on Non-surgical and Surgical Therapy for the Management of Residual Pockets of Periodontitis Patients in Faculty of Dentistry Universiti Teknologi MARA: A Pilot Study

Nurul Qamar Salehuddin[1], Budi Aslinie Md Sabri[2] and Farha Ariffin[1,*]

[1]Centre of Periodontology Studies, Faculty of Dentistry, Universiti Teknologi MARA Sungai Buloh Campus, Jalan Hospital, 47000 Sungai Buloh, Selangor, Malaysia.

[2]Centre of Population Oral Health and Clinical Prevention, Faculty of Dentistry, Universiti Teknologi MARA Sungai Buloh Campus, Jalan Hospital, 47000 Sungai Buloh, Selangor, Malaysia.

Corresponding Author:

drfarha@uitm.edu.my

Tel: +60361266464

Received: September 10, 2021
Accepted for publication: November 16, 2021

DOI: https://doi.org/10.24191/cos.v9i1.16893

ABSTRACT

This study aims to quantify and analyze the cost distribution of periodontal intervention that includes non-surgical and surgical therapy in residual pockets management. Immediately after initial cause-related therapy (ICRT), subjects were allocated into two treatment groups: non-surgical (NS) or surgical (S) therapy. Clinical and cost data were recorded at baseline (Phase I) and periodontal review (Phase II). Direct and indirect cost distribution were estimated from patients' perspective and recorded in Ringgit Malaysia (RM) using activity-based costing methods. Indirect cost was calculated via productivity loss. The total average cost was RM1115.68 for the NS group and RM4558.28 for the S group. 46% and 66%of these were attributed to indirect cost while 54% and 34%to direct cost in NS and S groups respectively. Treatment charges and productivity lost attributed to the highest cost distribution in direct and indirect cost respectively. In conclusion, the cost of management of residual pockets in postgraduate periodontic clinic, Faculty of Dentistry UiTM was considered substantial and comparable to other non-communicable diseases and higher compared to management by government-based Periodontic Specialist clinics in

Malaysia. These findings may assist in cost-reduction strategies and further justify the need for early detection and prevention of further disease progression.

Keywords: *Cost Analysis, Periodontal Therapy, Non-surgical Therapy, Surgical Therapy, Periodontitis*

INTRODUCTION

The concept of managing periodontitis is similar in any healthcare programme where the best-desired outcomes should be delivered within the limited resources. The foundation of economics is based on scarcity, where there are limitations of sources in terms of time availability, access to equipment, consumables, and financial resources(Vernazza *et al.*, 2012; Drummond *et al.*, 2015). All of these resources are essential in the provision of services to gain a healthy state. Therefore, it is always necessary to decide and choose the best way to optimize these resources. In order to make these decisions, alternative interventions competing for these resources must be evaluated.

An economic evaluation in periodontal treatment plays a significant societal interest in determining which treatment modality provides the greatest 'value for money' (Vernazza *et al.*, 2012). Works of literature have proven the efficacy of both the active phase and maintenance phase of periodontal treatment in reducing tooth loss (Hirschfeld and Wasserman, 1978; Eickholz *et al.*, 2008; Farina *et al.*, 2021; Guarnieri *et al.*, 2021) and improving the individual's quality of life (Bajwa, Watts and Newtonb, 2007; Tsakos *et al.*, 2010; Mendez *et al.*, 2021). A variety of economic evaluation methods could be applied in identifying the best suited periodontal treatment in managing residual pockets immediately after initial cause-related therapy (ICRT). Firstly is the cost-minimisation or generally termed cost analysis (Drummond, Sculpher, *et al.*, 2015). In this analysis, the cost of each treatment was calculated by basic operations of mathematics which is addition of related cost in each treatment (Vernazza, Heasman, *et al.*, 2012; Drummond, Sculpher, *et al.*, 2015). Secondly is the cost-benefit analysis (CBA). This analysis assigns a monetary unit to periodontal surgery benefits (Vernazza, Heasman, *et al.*, 2012; Drummond, Sculpher, *et al.*, 2015). The most currently used economic evaluation is cost-effectiveness analysis (CEA). Cost-effectiveness analysis represents the health benefits in natural units or measures of health-related quality of life (Drummond, Sculpher, *et al.*, 2015). And finally, cost-utility analysis (CUA). The utility units are usually combined with the time spent in a state of health to generate a number of quality-adjusted life-years (QALYs). QALY is equivalent to one year in a healthy state. This analysis generated the cost per outcome that was expressed as incremental cost-effectiveness ratio (ICER).

Generally, the cost-minimization or cost analysis (Drummond *et al.*, 2015) are usually applied in the decision-making process (Briggs and O'Brien, 2001; Vernazza *et al.*, 2012). However, previous literatures mainly focus on the cost of specific intervention rather than cost estimation on managing the disease as a whole (Braegger, 2005; Gjermo and Grytten, 2009; Heasman *et al.*, 2011). According to Drummond *et al*., cost-of-illness or burden-of-illness constitutes the economic evaluation in healthcare programmes (Drummond *et al.*, 2015). The cost-of-illness analysis approach provides information on measuring the burden of a disease economically by using a prevalence-based or an incidence-based approach. The difference between prevalence-based and incidence-based approaches is the timeframe of the cost estimation, where the former approach measuring the cost of a disease within a certain period. In contrast, the latter approach involves a lifetime cost estimation of new cases from the onset of the illness until cure or death in a given period (Tarricone, 2006).

In the field of periodontology, cost analysis studies by the application of the cost-of-illness approach are limited. A study by Fardal *et al*. reported on lifelong cost estimation of periodontitis in a specialist practice (Fardal *et al.*, 2012). Another study by Miremadi *et al*. is on the cost-effectiveness of non-surgical and surgical therapies on residual pockets within one year (Miremadi *et al.*, 2014). However, the cost estimation in these studies only considers treatment charges, third-party reimbursements, or

national expenditures. As from societal perspective, a study by Mohd. Dom et al. calculating the cost both from patient perspective as well as provider perspective in government-based periodontic specialist clinic in Malaysia (Mohd Dom *et al.*, 2014).

Over the past decades, cost analysis has been increasingly established as an important aspect of decision-making in periodontal therapy. This increasing interest in the healthcare system is due to limited resources such as finance, equipment and consumable as well as time availability (Vernazza *et al.*, 2012). Therefore, there's always a need to decide and make the best choices in using these limited resources. Hence, the current study aims to quantify the cost of periodontal intervention from patients' perspective that includes non-surgical and surgical therapy in managing residual pockets immediately after ICRT in learning-based facility and further analyze the cost distribution.

METHOD

Ethics

Ethical approval was received from the research ethics committee of the Universiti Teknologi MARA (Ref No. 600-IRMI [5/1/6]) prior to patient enrolment.

Study design and population

The study was planned as a non-randomized controlled trial involving non-surgical and surgical therapy on residual pockets of patients diagnosed with Stage III Periodontitis. Subjects were recruited, and all treatments were conducted in the Faculty of Dentistry Universiti Teknologi MARA (UiTM), Sungai Buloh, Selangor, Malaysia, from September 2018-July 2020. Subjects included in the study was based on these criteria: those that were diagnosed with generalized/localized Stage III Periodontitis (interdental CAL 1 ≥5 mm-at sites of most significant loss) with radiographic bone loss extending to the middle third of the root and beyond and/or furcation involvement (Class I and II) with PPD ≥6 mm and CAL ≥5 mm (Papapanou *et al.*, 2018) with at least one site per quadrant; recorded full mouth plaque score ≤25% during baseline and able to give informed consent. Subjects with the following criteria were excluded from the study: pregnant or lactating mothers; subjects that needed any prophylactic antibiotic administration due to a medical condition before dental treatment; subjects with an intellectual or physical disability that impedes oral hygiene techniques; those with uncontrolled diabetes (with HbA1c ≥8%) or taking medications that may affect gingival overgrowth (e.g., Calcium Channel blockers- amlodipine, verapamil; Anticonvulsant-phenytoin; Immunosuppressant- cyclosporine) and current smoker (including those that smokes for the past six months).

Periodontal Examination and Treatment Procedures

Prior to participation in the study, written and verbal consent was taken from the patients. Clinical parameters include probing pocket depth (PPD) and clinical attachment levels (CAL). Other clinical parameters, including bleeding score and number of sites and tooth involved per patient, were also recorded. The subjects must have undergone ICRT, which consist of standard oral hygiene motivation and instruction; full mouth scaling and polishing as well as SRD on PPD ≥5mm, which was performed per quadrant using *Gracey* curettes and an ultrasonic scaler, under local anaesthesia; irrigations with 0.12% chlorhexidine mouthwash for PPD ≥5mm after the completion of scaling and subgingival root debridement (SRD).During periodontal review, which was two months after ICRT, subjects were then allocated either into NS or S groups. In NS group, subjects underwent; full mouth scaling and SRD performed per quadrant using *Gracey* curettes and an ultrasonic scaler under local anaesthesia, and irrigations with 0.12% chlorhexidine mouthwash were done for PPD ≥6mm. As for subjects under S group, they underwent; full mouth scaling and polishing and access flap (AF) surgery and open flap debridement with osteoplasty; all surgeries were performed per quadrant using *Gracey* curettes and an ultrasonic scaler, under local anaesthesia and irrigations were done with 0.12% chlorhexidine mouthwash for PPD ≥6mm. Each subject was reviewed

one-week post-quadrant-based surgery for the removal of sutures. Subjects were reviewed again after 3 months for all periodontal parameter's measurement.

Cost Analysis

Cost estimation, identification and calculation was based on the methods proposed by Drummond et al. (2015), Mohd Dom et al. (2014) and Chai et al. (Chai and Lee, 2009). The summary of the cost involved is as described in Table 1.

Table1: Summary of Total Cost Involved

No	Cost	Description
1	Cost of Treatment	Cost of treatment imposed for periodontal review (during baseline and at three-months review) Cost of treatment for scaling and root debridement per sextant (for NS group). Cost of treatment for access flap surgery per sextant with one-week review (for S group).
2	Travel Cost	Average fuel consumption per day (back and to Faculty of Dentistry, UiTM Sg Buloh). Toll cost per day (back and Faculty of Dentistry, UiTM Sg Buloh).
3	Cost on Meals and Beverages	Meals and beverages consumption per day for each visit.
4	Registration Charges	Fees imposed on each visit for each group based on Fees and Charges of Faculty of Dentistry, UiTM Sg Buloh (2019)-postgraduate service charge.
5	Productivity Loss	Estimation of cost based on the average income daily by interview with patient (during visits or by phone calls or messages by NQS). Estimation of cost for pensioners, retirees and homemakers are made based on median household disposable income per day reported by Department of Satistics in Malaysian Population-urban area (*Department of Statistics Malaysia*, 2019).

The cost involved in this study is estimated from the patients' point of view and was recorded from baseline (Phase I) up to review at three months after treatment completed (Phase III). Thus, the costs borne by the patients are included in the total expenses of each treatment given, which includes direct and indirect cost (Figure 1). The cost involved consists of the cost for each treatment received by the patient, travel cost, meals and beverages consumption, registration fees, and productivity loss in each treatment received, as shown in Table 1. Fees for each treatment received for each group is based on UiTM dental fees (2019). Travel cost includes toll cost and average fuel consumption (Chai and Lee, 2009). Loss of productivity was calculated based on patients' recorded income per day using the human capital approach. The human capital approach estimates the illness effect on the wages or production rates termed productivity loss (Drummond et al., 2015). As for pensioners, retirees, and homemakers, the productivity loss was assumed and estimated based on monthly disposable income in urban areas according to national statistics data on household income, RM4912.00 (Department of Statistics Malaysia, 2019) since no income are generated monthly. All cost reports are conducted either by interview or by phone calls or messages by NQS.

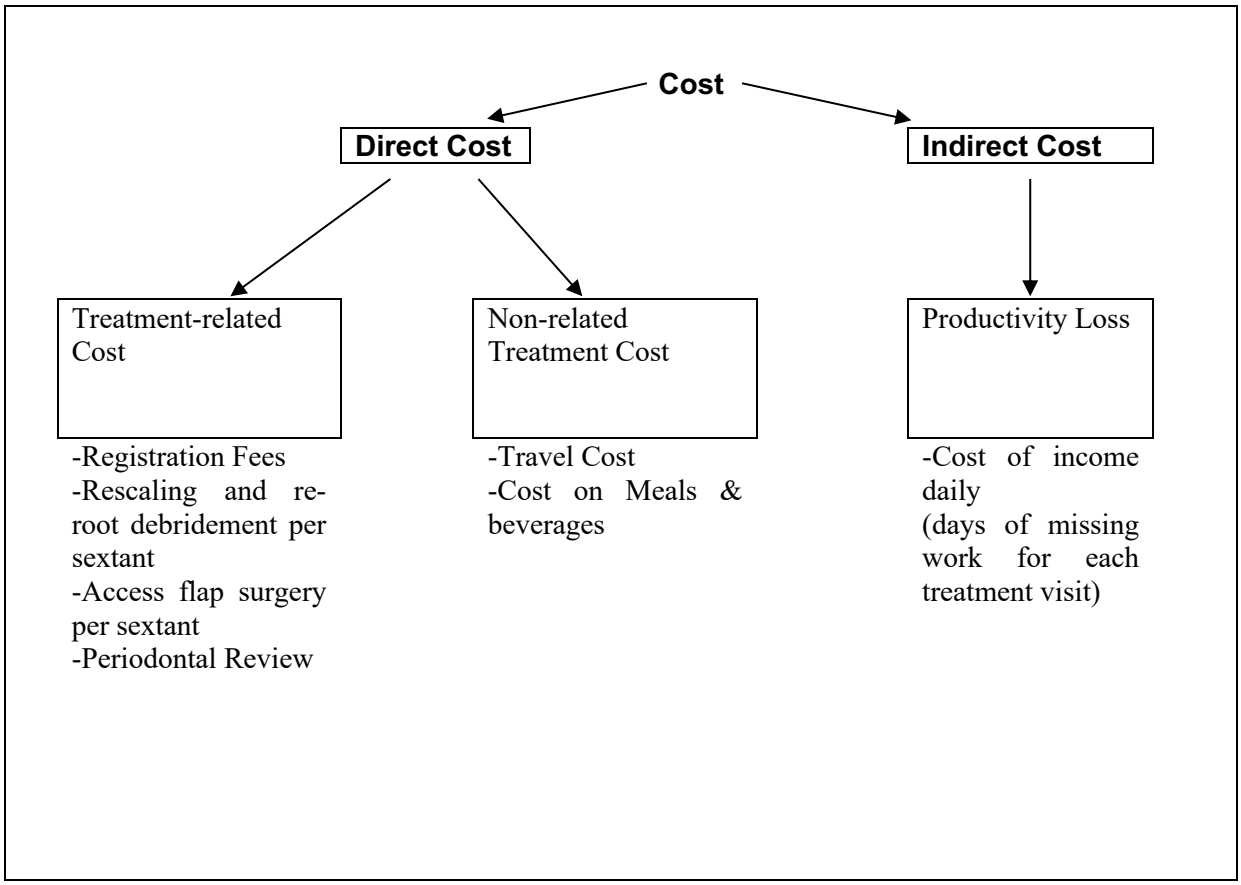

Figure 1: Cost Components involved from Phase I up to Phase II

The total cost was calculated by summation of all the cost involved throughout the treatment procedure from Phase I to Phase III. It was presented in Ringgit Malaysia (RM), as summarised in Figure 2 for the NS group and Figure 3 for the S group.

Total cost	=	Treatment Cost (NS treatment per sextant, Periodontal review) + Travel Cost + Meals and Beverages Cost +Registration Fees + Productivity loss

Figure 2: Total Cost involved in Non-surgical Group

Total cost	=	Treatment Cost (S treatment per sextant, Periodontal review) + Travel Cost + Meals and Beverages Cost +Registration Fees + Productivity loss

Figure 3: Total Cost involved in Surgical Group

Statistical Analysis

Data on cost was recorded and calculated with Microsoft Excel 2017. As for the demographic and baseline data, IBM SPSS Statistics Version 26 and Mann-Whitney U test were used to evaluate the differences of means between baseline data.

RESULTS

Socio-demographic at Baseline

A total of 10 patients (5 in each group) with Stage III Periodontitis were recruited. The mean age was 50.20(SD±6.72) in NS group and 53.40(SD±8.02) for the S group. Socio-demographic distribution and clinical parameters of included subjects at baseline are as shown in Table 2. Non-surgical and surgical management were provided in all four quadrants per patient.

Cost Analysis

Subjects estimated monthly income ranged from RM1200.00 to RM6000, with the lowest income reported in the NS group and the highest in the S group. The median monthly salary of those in the NS group was RM3000.00 (IQR=4800.00), while the median monthly salary of individuals in the S group was RM4912.00 (IQR=750.00). 60% of the NS sample population generate a monthly disposable income of less than RM4912.00. In contrast, 20% more of participants in the S group generate a monthly income up to RM4912.00. Table 3 shows the monthly income salary for both treatment groups.

Table 4 shows the descriptive data on the procedure involved for each treatment with number of visits for each procedure. Periodontal review cost per visit is RM50.00, as for rescaling and re-root debridement per sextant cost is RM80.00, and RM250.00 is the cost of access flap surgery per sextant, including one-week review. Table 5 shows the number of sextants and cost involved for each patient in each treatment group. The total cost for each treatment group was the summation of two periodontal review cost (Phase I and Phase II) and the total cost of procedures performed according to sextants involved. The highest expenditure for procedures incurred for NS group and S group was RM580.00 and RM1350.00, respectively. Table 6 shows descriptive statistics on the involved cost of each treatment group. The cost calculation consists of all the cost involved from Phase I to Phase II. The costs involved in the analysis include, mean of average fuel consumption, mean of cost for any toll tickets, mean total cost for each treatment group, mean of total registration fees involved, mean of average meals and beverages

consumption during treatment visits and mean productivity loss based on days missed at work. The distribution of cost components for direct and indirect cost in each group was summarized in Figure 4. Both groups showed similar trends on cost expenditures except for the treatment charges and registration fees. The highest percentage of total cost consumption was from the indirect cost (productivity loss) with 45.89% in the NS group and 66.43% in the S group. The most minor expenditures for both groups were toll charges, which amounted to less than 1%, with 0.69% for NS group and 0.79% for S group.

Table 2: Socio-demographic distribution and clinical parameters of subjects at baseline (N=10)

Variables	Non-surgical Group(n=5)	Surgical Group(n=5)	*p*-value
Gender			
Men	4	1	
Women	1	4	
Level of Education			
Secondary school	4	2	
Tertiary education	1	3	
Mean age (years mean; SD)	50.20 (6.72)	53.40 (8.02)	0.40
PPD (mm mean; SD)	6.08 (0.44)	6.67 (0.52)	0.12
CAL (mm mean; SD)	6.88 (0.82)	7.66 (1.19)	0.25
Full-mouth bleeding score (FMBS; %)	36.34 (10.54)	45.4 (22.69)	0.60
Sites with PPD >4mm	4.60 (3.21)	4.60 (4.83)	0.53
Sites with PPD >5mm	8.00 (4.64)	13.80 (6.26)	0.21
Nunber of teeth involved:			
Molars	4.40 (1.82)	3.60 (1.14)	0.45
Premolars	2.20 (1.92)	2.20 (1.10)	0.91
Anteriors	2.40 (3.05)	3.00 (2.45)	0.67

Table 3: Distribution of Monthly Income in both Treatment Groups

Monthly Income	Non-Surgical (NS) Group		Surgical (S) Group	
	n	%	n	%
Up to RM4912.00	3	60	4	80
More than RM4912.00	2	40	1	20
Total	5	100	5	100

Table 4: Descriptive Data on the Cost involved in Non-surgical and Surgical Treatment (from Phase I to Phase II)

Procedure	Non-Surgical Group	Surgical Group
	No. of Visits	No. of Visits
Periodontal Review	2	2
Rescaling and Re-root debridement per sextant	2	-
Access Flap Surgery per sextant	-	4
Review One-week after Surgery	-	4
Total visits	4	10

Table 5: Total treatment Cost and Number of Sextant involved in each Subject

No	Non-Surgical Group (n=5)		Surgical Group (n=5)	
	No. of Sextant involved in Rescaling and Re-root Debridement	Total Cost (RM) [Procedural Cost + Two Periodontal Review Cost]	No. of Sextant involved in Access Flap Surgery including One-week Review	Total Cost (RM) [Procedural Cost + Two Periodontal Review Cost]
1	5	500.00	-	-
2	6	580.00	-	-
3	4	520.00	-	-
4	4	520.00	-	-
5	5	500.00	-	-
6	-	-	4	1100.00
7	-	-	4	1100.00
8	-	-	4	1100.00
9	-	-	5	1350.00
10	-	-	4	1100.00

Table 6: Descriptive Statistics on the involved Cost for each Treatment Group

Cost Unit	Non-Surgical Group (n=5) Mean (SD)	Surgical Group (n=5) Mean (SD)
Direct Cost		
Registration	20.00 (0.00)	50.00 (0.00)
Treatment	484.00 (66.93)	1150.00 (111.80)
Fuel	36.00 (28.84)	134.00 (74.36)
Toll	7.68 (11.44)	36.00 (49.79)
Meals and Beverages	56.00 (16.73)	160.00 (41.83)
Indirect Cost		
Productivity Loss	512.00(331.54)	3028.28 (337.03)
Total	1115.68 (321.56)	4558.29 (450.44)

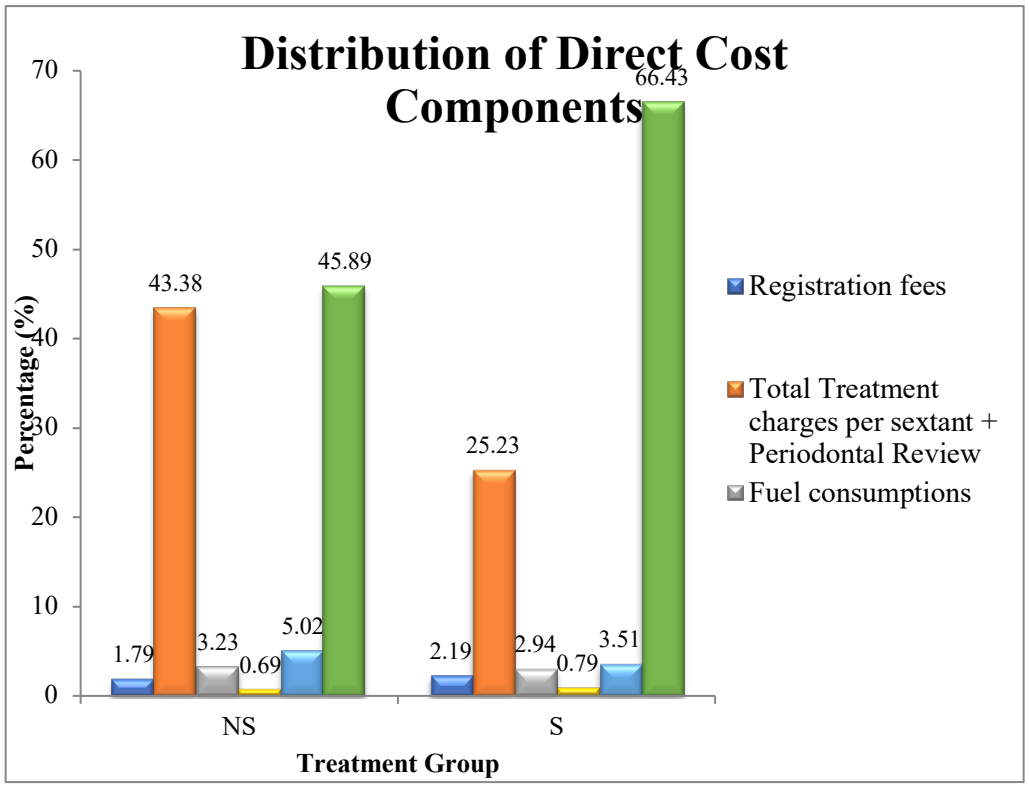

Figure 4: Distribution of Cost Components for NS and S group

DISCUSSIONS

The cost calculation was performed based on patient-level data where the total cost was the summation of the treatment cost (the cost of treatment per sextant with the cost for review, the cost for travel (estimation on the toll cost and fuel cost per visit), estimation on the meals and beverages per visit, registration cost per visit and productivity loss (Mohd Dom, 2013; Drummond *et al.*, 2015). Cost estimation for patient-related-clinical activities by activity-based costing approach as described above was more accurate than other costing methods (Yen-Ju Lin *et al.*, 2007). Furthermore, cost of illness studies has been reported to be beneficial in justifying intervention programmes and thus useful in budget or resources allocation and can provide a financial framework for programme evaluation (Rice, 2000).

In this study, the total cost for managing residual pockets at the patient-level was RM1115.68 and RM4558.28 for non-surgical and surgical approaches, respectively. The cost of surgical intervention was anticipated to be higher than the non-surgical management. Similar findings on the total cost seen in a study by Mohd. Dom et al. (2014), where the total cost of managing periodontitis patient within one year in Specialist Periodontic clinic from societal perspective is RM1962 in NS group and RM5103 in S group (Mohd Dom *et al.*, 2014).Although in terms of figures it appears that the total cost in this study is lower than the total cost of periodontal management by government-based specialist periodontic clinic in Malaysia, it can be postulated that our finding showed higher total cost incurred for both groups. This may be because our study only calculated the patient level data cost without inclusion of provider cost. Provider cost in their study inclusive of various cost. The medical/dental cost include diagnostics, non-surgical periodontal therapy and surgical intervention. And for the non-medical/dental cost, programme administration, physical space, and utilities (water, electricity, telephone).

The cost for surgical intervention by AF surgery was almost five times greater than the non-surgical approach cost. This is due to the procedural cost and the frequency of visits for the review after surgery. The number of visits for those under S group where a doubled number of visits seen and thus posted higher cost on the registration fees as more frequent visits are required. This can be interpreted that surgical intervention posted greater resource-consuming than non-surgical therapy. Out of the total cost, almost half of the cost (45.89%) in NS group and two-third of the cost (66.43%) in S group was indirect cost. As mentioned earlier, this estimation on the productivity loss was also associated with the number of treatment visits as more visits are required in the surgical group compared to non-surgical group. Although the subjects in this study were followed up only until the completion of the intervention after ICRT, which is the corrective phase, the highest cost consumption was during this phase. Following this phase, the maintenance phase took up a lower number of visits than the corrective phase. Thus, the cost of subsequent management may be lower than this phase, provided that high adherence to maintenance visits and home care controls are implemented (Mohd-Dom *et al.*, 2014). Some studies reported the cost based on insurance claims (Pretzl *et al.*, 2009; Fardal *et al.*, 2012). Miremadi *et al.* studied almost similar comparisons in relation to clinical outcomes and have shown that the open flap debridement is more costly than scaling and re-root debridement in a Belgian institution setting (Miremadi *et al.*, 2014). However, the cost estimations are only based on the cost per procedure given without assessing other miscellaneous expenses that have to be bear by patients. Other studies (Kowash, Toumba and Curzon, 2006; Bouchard *et al.*, 2009; Listl and Faggion, 2010; Lopes Martins *et al.*, 2021) calculated the costs based on the provider point of view, such as employee salaries per visit, procedural cost and cost per capita. The results obtained from this study have similarities to the results derived from prior studies; non-surgical treatment procedures are more economical than periodontal surgeries (Braegger, 2005; Mohd Dom, 2013; Miremadi *et al.*, 2014).

In a study of cost by Albert *et al*., higher medical costs were incurred for those diagnosed with periodontitis and diabetes mellitus (DM) (RM1434.48) or cardiovascular disease (CVD) (RM2017.35) than those who underwent gingivitis treatment only (RM1516.03 in DM patients and RM1752.22 in CVD

patients) (Albert *et al.*, 2006). A more recent study by Nasseh and colleagues made comparison on cost and association between those who do not take any DM type 2 drug prescription and those with DM drug prescription therapy with periodontal intervention given within 3 to 4 years of treatment. The former group reported with higher total cost RM7535.11 (Nasseh, Vujicic and Glick, 2017). In this present study, the highest direct cost distribution for both treatment groups are from the treatment charges with RM484 and RM1150 in NS and S group respectively. Furthermore, those who underwent periodontal therapy regardless of treatment groups with higher number of sextants affected contributed to higher cost for treatment charges. Similar non-communicable diseases such as hypertension also showed similar pattern of cost distribution where medications costs were the highest amount in the direct cost RM19.75 for drugs alone out of direct total cost, RM27.22 in Stage 2 hypertension (Alefan *et al.*, 2009).

Productivity loss accounts for almost half in the NS group and two-thirds of the total cost in S group in managing residual pockets immediately after ICRT. This may be attributed to frequent number of visits to the clinic to complete the treatment procedure. The indirect cost was calculated as daily productivity loss. This calculation was assumed to be relevant as an estimation of time spent in the clinic for treatment procedures (Mohd Dom, 2013).

However, this study excludes the oral care products expenses calculation. Oral care products such as toothbrushes, interdental brushes, floss, or other mechanical oral aids are essential during the maintenance phase. It plays a significant role in halting the disease progression (Van Der Weijden and Slot, 2011). Therefore, purchasing these oral aids may considerately post a financial burden to the patients and affect their self-plaque control and consequently affect the treatment outcomes.

CONCLUSION

In this cost analysis pilot study, the cost-of-illness method was applied to estimate the cost and compare two treatment modalities (rescaling and re-root debridement alone against access flap surgery with rescaling and re-root debridement) on residual pockets management immediately after ICRT. The results showed that the cost of management of residual pockets was considered substantial and comparable with management cost of other non-communicable diseases. In NS group, 46% of total cost were indirect cost and 54% were direct cost. In contrast, the surgical group's total cost comprises 66% of indirect cost and 34% of direct cost. However, the cost of management of residual pockets in Faculty of Dentistry UiTM was found to be higher compared to government periodontic specialist clinic. Nevertheless, the distribution within indirect cost is almost similar in pattern for both treatment groups. The productivity loss accounted for the highest cost contribution to the total cost in both treatment groups and treatment charges accounted for the highest cost in the total direct cost. These findings may assist in cost-reduction strategies, hence providing a basis for residual pockets management's economic evaluation. Furthermore, these results may further justify the needs in early detection and prevention of further disease progression that eventually helps reduce the cost of periodontal therapy in more severe periodontitis cases that are more costly.

ACKNOWLEDGEMENTS

The authors acknowledge the help and support of the faculty's statistician, dental surgery assistants, undergraduate students, periodontics postgraduate residents, and academic staff.

CONFLICT OF INTEREST

The author(s) declare no potential conflicts of interest.

FUNDING

Internal grant of Universiti Teknologi MARA 400-FPG (PT.23/3/2) 22/06/2018.

REFERENCES

Albert, D. A. *et al.* (2006) 'An examination of periodontal treatment and per member per month (PMPM) medical costs in an insured population', *BMC Health Services Research 2006 6:1*. BioMed Central, 6(1), pp. 1–10. doi: 10.1186/1472-6963-6-103.

Alefan, Q. *et al.* (2009) 'Cost of treating Hypertension in Malaysia', *Asian Journal of Pharmaceutical and Clinical Research*, 2(1), pp. 1–5.

Bajwa, A., Watts, T. L. P. and Newtonb, J. T. (2007) 'Health control beliefs and quality of life considerations before and during periodontal treatment', *Oral Health & Preventive Dentistry*, 5(2), pp. 101–104. doi: 10.3290/j.ohpd.a12300.

Bouchard, P. *et al.* (2009) 'Cost-effectiveness modeling of dental implant vs. bridge', *Clinical Oral Implants Research*. John Wiley & Sons, Ltd, 20(6), pp. 583–587. doi: 10.1111/j.1600-0501.2008.01702.x.

Braegger, U. (2005) 'Cost-benefit, cost-effectiveness and cost-utility analyses of periodontitis prevention', in *Journal of Clinical Periodontology*, pp. 301–313. doi: 10.1111/j.1600-051X.2005.00802.x.

Briggs, A. H. and O'Brien, B. J. (2001) 'The death of cost-minimization analysis?', *Health Economics*. John Wiley & Sons, Ltd, 10(2), pp. 179–184. doi: 10.1002/hec.584.

Chai, P. F. and Lee, W. S. (2009) 'Out-of-pocket costs associated with rotavirus gastroenteritis requiring hospitalization in Malaysia', *Vaccine*, 27(SUPPL. 5). doi: 10.1016/j.vaccine.2009.08.069.

Department of Statistics Malaysia (2019). Available at: https://www.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=120&bul_id=TU00TmRhQ1N5TUxHVWN0T2VjbXJYZz09&menu_id=amVoWU54UTl0a21NWmdhMjFMMWcyZz09 (Accessed: 5 February 2021).

Drummond, M. *et al.* (2015) *Methods for the economic evaluation of healthcare programmes*, *Methods for the Economic Evaluation of Health Care Programmes*.

Eickholz, P. *et al.* (2008) 'Tooth loss after active periodontal therapy. 1: patient-related factors for risk, prognosis, and quality of outcome', *Journal of Clinical Periodontology*. John Wiley & Sons, Ltd, 35(2), pp. 165–174. doi: 10.1111/j.1600-051X.2007.01184.x.

Fardal, Ø. *et al.* (2012) 'The Lifetime Direct Cost of Periodontal Treatment: A Case Study From a Norwegian Specialist Practice', *Journal of Periodontology*. Wiley-Blackwell, 83(12), pp. 1455–1462. doi: 10.1902/jop.2012.110689.

Farina, R. *et al.* (2021) 'Tooth loss in complying and non-complying periodontitis patients with different periodontal risk levels during supportive periodontal care', *Clinical Oral Investigations*. Springer Science and Business Media Deutschland GmbH, pp. 1–10. doi: 10.1007/s00784-021-03895-8.

Gjermo, P. E. and Grytten, J. (2009) 'Cost-effectiveness of various treatment modalities for adult chronic periodontitis', *Periodontology 2000*, 51(1), pp. 269–275. doi: 10.1111/j.1600-0757.2009.00313.x.

Guarnieri, R. *et al.* (2021) 'Longevity of Teeth and Dental Implants in Patients Treated for Chronic Periodontitis Following Periodontal Maintenance Therapy in a Private Specialist Practice: A Retrospective Study with a 10-Year Follow-up', *The International Journal of Periodontics & Restorative Dentistry*. Quintessence Publishing, 41(1), pp. 89–98. doi: 10.11607/prd.4674.

Heasman, P. A. *et al.* (2011) 'Cost-effectiveness of adjunctive antimicrobials in the treatment of periodontitis', *Periodontology 2000*. John Wiley & Sons, Ltd, 55(1), pp. 217–230. doi: 10.1111/j.1600-0757.2010.00341.x.

Hirschfeld, L. and Wasserman, B. (1978) 'A Long-Term Survey of Tooth Loss in 600 Treated Periodontal Patients', *Journal of Periodontology*. Wiley, 49(5), pp. 225–237. doi: 10.1902/jop.1978.49.5.225.

Kowash, M. B., Toumba, K. J. and Curzon, M. E. (2006) 'Cost-effectiveness of a long-term dental health education program for the prevention of early childhood caries.', *European archives of paediatric dentistry : official journal of the European Academy of Paediatric Dentistry*. Springer, 7(3), pp. 130–135. doi: 10.1007/BF03262553.

Listl, S. and Faggion, C. M. (2010) 'An economic evaluation of different sinus lift techniques', *Journal of Clinical Periodontology*. John Wiley & Sons, Ltd, 37(8), p. no-no. doi: 10.1111/j.1600-051X.2010.01577.x.

Lopes Martins, A. F. *et al.* (2021) 'Cost-effectiveness randomized clinical trial on the effect of photobiomodulation therapy for prevention of radiotherapy-induced severe oral mucositis in a Brazilian cancer hospital setting', *Supportive Care in Cancer*. Springer Science and Business Media Deutschland GmbH, 29(3), pp. 1245–1256. doi: 10.1007/s00520-020-05607-6.

Mendez, M. *et al.* (2021) 'Oral health-related quality of life during supportive periodontal therapy: results from a randomized clinical trial', *Journal of Clinical Periodontology*. John Wiley & Sons, Ltd, p. jcpe.13473. doi: 10.1111/jcpe.13473.

Miremadi, S. R. *et al.* (2014) 'A randomized controlled trial on immediate surgery *versus* root planing in patients with advanced periodontal disease: a cost-effectiveness analysis', *Journal of Clinical Periodontology*. John Wiley & Sons, Ltd, 41(2), pp. 164–171. doi: 10.1111/jcpe.12201.

Mohd-Dom, T. *et al.* (2014) 'Cost analysis of Periodontitis management in public sector specialist dental clinics', *BMC Oral Health*. BioMed Central Ltd., 14(1). doi: 10.1186/1472-6831-14-56.

Mohd Dom, T. N. (2013) 'Economic Burden and Cost-Effectiveness Analysis of Periodontitis Management in Malaysia', *Unpublished Thesis of Degree of Doctor of Philosophy*.

Mohd Dom, T. N. *et al.* (2014) 'Cost analysis of Periodontitis management in public sector specialist dental clinics', *BMC Oral Health*. BioMed Central Ltd., 14(1). doi: 10.1186/1472-6831-14-56.

Nasseh, K., Vujicic, M. and Glick, M. (2017) 'The Relationship between Periodontal Interventions and Healthcare Costs and Utilization. Evidence from an Integrated Dental, Medical, and Pharmacy Commercial Claims Database', *Health Economics*. John Wiley & Sons, Ltd, 26(4), pp. 519–527. doi: 10.1002/HEC.3316.

Papapanou, P. N. *et al.* (2018) 'Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions', *Journal of Clinical Periodontology*, 45, pp. S162–S170. doi: 10.1111/jcpe.12946.

Pretzl, B. *et al.* (2009) 'Effort and costs of tooth preservation in supportive periodontal treatment in a German population', *Journal of Clinical Periodontology*. John Wiley & Sons, Ltd, 36(8), pp. 669–676. doi: 10.1111/j.1600-051X.2009.01409.x.

Rice, D. P. (2000) 'Cost of illness studies: what is good about them?', *Injury Prevention*. BMJ Publishing Group Ltd, 6(3), pp. 177–179. doi: 10.1136/IP.6.3.177.

Tarricone, R. (2006) 'Cost-of-illness analysis: What room in health economics?', *Health Policy*. Elsevier, 77(1), pp. 51–63. doi: 10.1016/J.HEALTHPOL.2005.07.016.

Tsakos, G. *et al.* (2010) 'Assessing the minimally important difference in the Oral Impact on Daily Performances index in patients treated for periodontitis', *Journal of Clinical Periodontology*. John Wiley & Sons, Ltd, 37(10), pp. 903–909. doi: 10.1111/j.1600-051X.2010.01583.x.

Vernazza, C. *et al.* (2012) 'How to measure the cost-effectiveness of periodontal treatments', *Periodontology 2000*. Periodontol 2000, 60(1), pp. 138–146. doi: 10.1111/j.1600-0757.2011.00406.x.

Van Der Weijden, F. and Slot, D. E. (2011) 'Oral hygiene in the prevention of periodontal diseases: the evidence', *Periodontology 2000*. John Wiley & Sons, Ltd, 55(1), pp. 104–123. doi: 10.1111/j.1600-0757.2009.00337.x.

Yen-Ju Lin, B. *et al.* (2007) 'How can activity-based costing methodology be performed as a powerful tool to calculate costs and secure appropriate patient care?', *Journal of Medical Systems*. Springer, 31(2), pp. 85–90. doi: 10.1007/s10916-005-9010-z.