Incorporating Severity and Risk as Factors to the Fardal Cost-Effectiveness Model to Create a Cost–Benefit Model for Periodontal Treatment

John A. Martin,* Øystein Fardal,† Roy C. Page,‡ Carl F. Loeb,§ Elizabeth Krall Kaye,‖ Raul I. Garcia,‖¶ and Gerard J. Linden#

Background: A previously described economic model was based on average values for patients diagnosed with chronic periodontitis (CP). However, tooth loss varies among treated patients and factors for tooth loss include CP severity and risk. The model was refined to incorporate CP severity and risk to determine the cost of treating a specific level of CP severity and risk that is associated with the benefit of tooth preservation.

Methods: A population that received and another that did not receive periodontal treatment were used to determine treatment costs and tooth loss. The number of teeth preserved was the difference of the number of teeth lost between the two populations. The cost of periodontal treatment was divided by the number of teeth preserved for combinations of CP severity and risk.

Results: The cost of periodontal treatment divided by the number of teeth preserved ranged from (US) $1,405 to $4,895 for high or moderate risk combined with any severity of CP and was more than $8,639 for low risk combined with mild CP. The cost of a three-unit bridge was $3,416, and the cost of a single-tooth replacement was $4,787.

Conclusion: Periodontal treatment could be justified on the sole basis of tooth preservation when CP risk is moderate or high regardless of disease severity. *J Periodontol 2014;85:e31-e39.*

KEY WORDS

Chronic periodontitis; cost-benefit analysis; economics.

* Private practice, State College, PA.
† Private practice, Egersund, Norway.
‡ Department of Periodontics, School of Dentistry, University of Washington, Seattle, WA.
§ PreViser Corporation, Mt. Vernon, WA.
‖ Department of Health Policy and Health Services Research, Boston University Henry M. Goldman School of Dental Medicine, Boston, MA.
¶ Veterans Affairs Boston Healthcare System, Boston, MA.
# Centre for Public Health, School of Medicine Dentistry and Biomedical Sciences, Queen's University, Belfast, Northern Ireland.

A recent study by Fardal et al.[1] reported that the direct life costs for periodontal therapy were cost effective if the patient chose not to have treatment for their periodontal condition and had no more than four teeth replaced with bridges or implants. The timeframe of the model was 33 years during periodontal maintenance and costs included: 1) periodontal scaling and surgery; 2) prosthetic tooth replacement; 3) follow-on costs of periodontal retreatment and prosthetic replacement; and 4) periodontal maintenance. The conclusion was based on average values for patients diagnosed with mild, moderate, or severe chronic periodontitis (CP). Regarding tooth loss, patients did not lose the same number of teeth. In fact, five of the 100 patients studied accounted for 42% of the teeth lost, 74% lost no teeth, and the number of teeth lost increased with increasing severity of CP,[2] which is consistent with other reports.[3-12] Reasons for this effect include: 1) tooth loss among individual patients varies as a consequence of progressive bone loss attributable to untreated CP over time;[13,14] 2) bone loss and tooth loss correlate to CP severity and risk;[15,16] 3) severity and risk of CP vary among patients;[12,16-18] and 4) response to periodontal treatment varies among

doi: 10.1902/jop.2013.130237

Table 1.

Factors to Quantify Periodontal Disease Severity and Risk

Severity[19]	Risk[15]
Deepest pocket in each sextant	Patient age
BOP for each sextant	Periodontal disease severity
Greatest radiographic bone loss in each sextant	Smoking history
	Diabetic status
	Periodontal treatment history
	Furcation involvements
	Vertical bone lesions
	Subgingival calculus or restorations

patients.[3-12,18] Refining the Fardal model of the lifetime direct cost of periodontal treatment to accommodate severity and risk as tooth loss predictors and indicated specific treatment may produce a model with greater precision and utility that could be helpful in making treatment decisions and designing an insurance plan. Accordingly, the purpose of this study is to describe a model of the cost of treating a specific level of CP severity and risk that is associated with the single benefit of tooth preservation.

MATERIALS AND METHODS

Fundamental to the present model is a categorization of CP severity and risk. For the categorization of CP severity, the present model uses the method reported by Page and Martin[19] that describes the severity and extent of CP of a dentition on a 1 (i.e., healthy) to 100 (i.e., severe periodontitis) score range. This method, which uses sextant measures of probing depth (PD), bleeding on probing (BOP), and bone loss (Table 1), has been demonstrated to be accurate and valid by statistical analysis using the strength of agreement of the scores with actual periodontal status of a dentition from values of alveolar bone height obtained from digitized radiographs. This method assigns a specific severity of periodontitis from one of health, gingivitis, mild, moderate, or severe periodontitis for each sextant and combines the results of the sextants to establish a severity score for the dentition. Severity scores from 4 to 10, 11 to 36, and 37 to 100 have been defined by the authors to be indicative of mild, moderate, and severe CP, respectively.

For the categorization of CP risk, the present model uses the method reported by Page et al.[15] that describes the likelihood and severity of periodontal deterioration and tooth loss over time when periodontal treatment is not provided. The method reports risk on a 1 (very low risk) to 5 (very high risk) score range using the factors listed in Table 1. Accuracy and validity of the risk score has been demonstrated by statistical analysis of actual bone loss from digitized radiographs and tooth loss from clinical records during a study period of 15 years.[15,20] For the present study, very low and low risk (scores 1 and 2) are combined for the category of low risk, and high and very high risk (scores 4 and 5) are combined for the category of high risk. The risk score 3 was used for the category of moderate risk.

The development of the present model required a means to determine the specific treatment indicated to treat CP and the number of teeth preserved. The number of preserved teeth is defined as the difference of the number of teeth lost when periodontal treatment is or is not provided. The information needed for these variables was derived from published studies of one population that received periodontal treatment and a second that received only routine dental care.[12,16]

The population that received periodontal treatment comprised 900 patients. One hundred fourteen patients were excluded from analysis resulting in 776 patients (sex not reported; aged 19 to 84 years; mean age: 46.0 years). Nine private practice periodontists each enrolled 100 consecutive patients presenting for maintenance care.[12] Information reported for each patient included severity and risk scores determined at the maintenance appointment from information documented at the diagnosis appointment, and because of this they had no effect on treatment. Treatment interventions provided after the diagnosis appointment were reported and included: 1) the number of quadrants of scaling and root planing (SRP); 2) the number of quadrants of surgery to reduce or eliminate pockets; 3) the number of periodontal maintenance procedures; 4) the number of periodontal surgical procedures not specifically intended to change PD; 5) the number of sites treated with local chemotherapy; 6) the number of weeks of systemic chemotherapy; and 7) the number of non-third molar teeth extracted, regardless of the clinician providing this service and regardless of the reason for the extraction. The study was approved as exempt by the Tufts Health Sciences Campus Institutional Review Board and granted a waiver of informed consent, and the initial publication of the study described tooth loss but not periodontal treatment.[12] Although many types of interventions are used to treat periodontal disease, the present model uses only SRP and osseous

Table 2.

Population Characteristics

		Routine Dental Care[16]		Periodontal Treatment[12]			
Risk	Severity	n	Tooth Loss Rate*	n	Tooth Loss Rate*	SRP†	Surgery†
High	Severe	91	0.355	548	0.139	3.32	2.80
High	Moderate	107	0.166	162	0.030	3.21	2.42
High	Mild	6	0.156	0	No data	No data	No data
Moderate	Severe	0	No data	0	No data	No data	No data
Moderate	Moderate	112	0.153	54	0.028	2.91	2.13
Moderate	Mild	66	0.067	7	0.013	2.29	2.57
Low	Severe	0	No data	0	No data	No data	No data
Low	Moderate	49	0.039	0	No data	No data	No data
Low	Mild	48	0.039	5	0.000	2.40	3.40

* Average tooth loss rate (i.e., the number of teeth lost per year per individual).
† Average number of quadrants.

surgery, defined as "surgery to reduce or eliminate pockets." Patients were excluded if the number of years between diagnosis and maintenance appointments was less than three. Table 2 shows the number of patients, the average tooth loss rate (i.e., number of teeth lost per year per patient), and the average number of quadrants for each of SRP and surgery for each of nine combinations of periodontitis severity and risk.

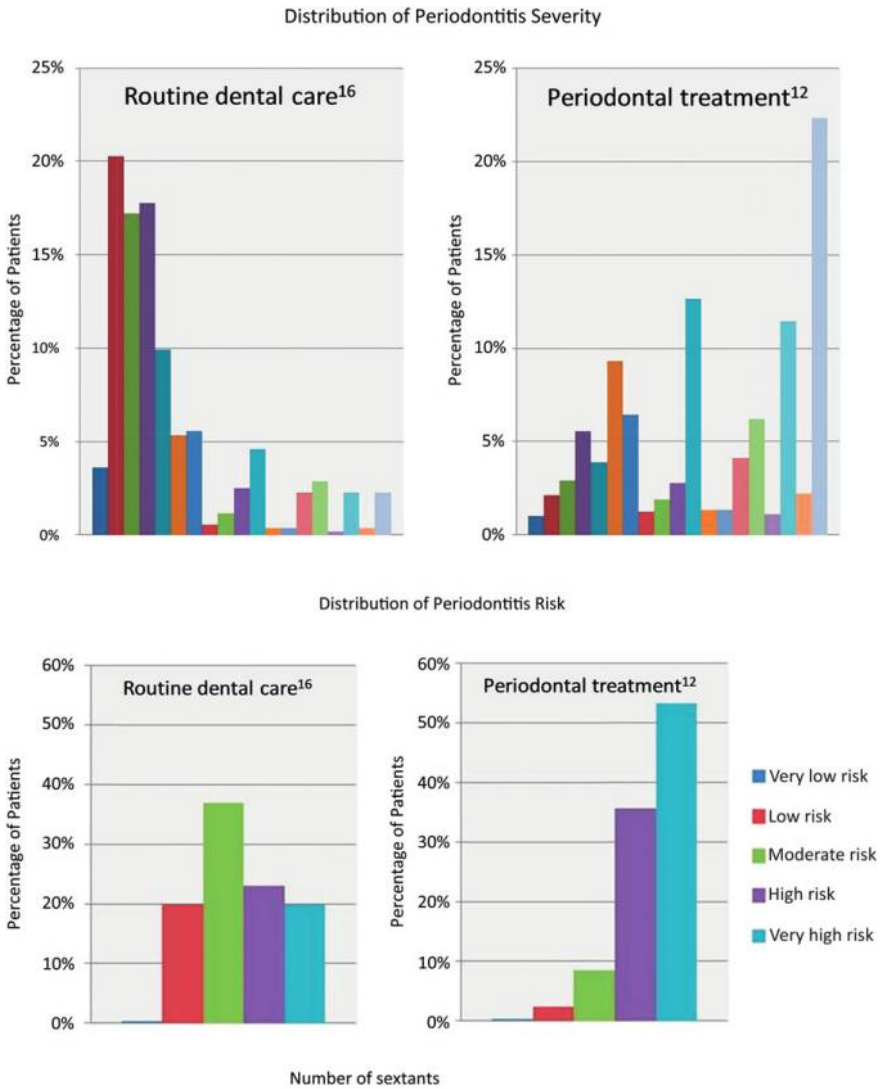
The population receiving only routine dental care was comprised of 523 male participants (aged 28 to 71 years; mean age: 47.3 years) in the Veterans Affairs Dental Longitudinal Study (VA DLS) and provided written oral consent.[16] These individuals were not patients of the Veterans Affairs health care system but received their dental and medical care from private health care providers. The vast majority of these individuals regularly saw their private dentists, received routine preventive and diagnostic services, and received various restorative and prosthetic services. As part of the VA DLS, they received triennial comprehensive oral exams, full-mouth radiographs, and prophylaxis. Each participant received written information and recommendations regarding needed care with a copy of the recommendations and radiographs mailed to their dentist. At each examination during the 15-year study period, each participant was also asked to respond yes or no to the question "have you had any gum treatments or gum surgery since your last examination?". Only 8% reported receiving periodontal treatment beyond routine prophylaxis during the study period. Severity and risk scores plus the number of teeth lost were determined from the clinical records. Participants who reported receiving periodontal treatment were excluded from the model. Table 2 shows the number of patients and the average tooth loss rate for each of nine combinations of periodontitis severity and risk. Additional information on this population was published previously.[15,16,20,21]

Figure 1 illustrates the precision of the methods to categorize CP severity and risk and the severity and risk distribution of the two populations.

The present model requires information on fees for periodontal and prosthetic treatment. For periodontal treatment, the weighted national 80th percentile fees of general dentists and periodontists for SRP (D4341) and osseous surgery (D4260) published in the American Dental Association 2011 Survey of Dental Fees[22] (Table 3) were used. Before selecting fees at the 80th percentile, little relative difference was found among fees at the 75th, 80th, 85th, 90th, and 95th percentiles, which implied that the results would be nearly identical regardless of which percentile was used.

The cost for periodontal treatment for each combination of periodontitis severity and risk was calculated by multiplying the number of quadrants of SRP from Table 2 by its fee in Table 3 plus the number of quadrants of osseous surgery from Table 2 and its fee in Table 3.

The number of teeth preserved by periodontal treatment was determined by subtracting the mean number of teeth lost for the periodontal treatment population from the mean number of teeth lost for



	Severe periodontitis	Moderate periodontitis	Mild periodontitis	Score range	Periodontitis Severity
1	0	0	1-2	4-7	Mild
2	0	0	3-6	8-10	
3	0	1	0-6	11-19	Moderate
4	0	2	0-4	20-26	
5	0	3	0-3	27-31	
6	0	4	0-2	32-34	
7	0	5-6	0-1	35-36	
8	1	0	0-5	37-46	Severe
9	1	1	0-4	47-54	
10	1	2	0-3	55-59	
11	1	3-5	0-2	60-64	
12	2	0	0-4	65-72	
13	2	1	0-3	73-77	
14	2	2	0-2	78-80	
15	2	3-4	0-1	81-82	
16	3	0	0-3	83-87	
17	3	1-3	0-2	88-92	
18	4	0	0-2	93-95	
19	4-6	0-2	0-1	96-100	

Figure 1.
The graphs illustrate the variation of CP severity and risk in a population in addition to the unique distribution for a specific population. Bar heights in each graph illustrate variation within a population. Respective bar heights of each population illustrate the unique distribution of severity (or risk) for the (specific) population. (The sequence of bars from left to right consistently corresponds to the same severity [or risk].)

routine dental care population at year 13 for each combination of periodontitis severity and risk (Fig. 2).

The cost of periodontal treatment associated with the benefit of preserving one tooth was calculated by dividing the cost of periodontal treatment by the number of teeth preserved for each combination of periodontitis severity and risk (Fig. 3A, bars).

Last, the cost to replace one tooth was determined by means of a three-unit fixed bridge (one pontic plus two retainer crowns) and single-tooth replacement (one implant plus one abutment plus one crown). Fees for the three-unit fixed bridge (D6240, D6750) and single-tooth replacement (D6010, D6057, D6066) were the weighted national 80th percentile fees of general dentists and periodontists published in the American Dental Association 2011 Survey of Dental Fees[22] (Fig. 3, horizontal lines).

RESULTS

Figure 2 shows that tooth loss for the two study populations diverge over time for each combination of periodontitis severity and risk. It also shows at year 13 the net difference of tooth loss per patient between the two populations ranged from 0.51 to 2.81.

The cost of periodontal treatment using general dentist fees ranged from (US) $3,097 to $4,380. When this cost is adjusted for the number of teeth preserved at year 13, the range was $1,405 to $8,639 (Fig. 3A). For treatment using periodontist fees, the cost of periodontal treatment ranged from $4,184 to $5,916. When this cost is

Table 3.

Weighted National 80th Percentile Fees[22]

Procedure	Code*	General Dentists	Periodontists
SRP	D4341	$251	$340
Osseous surgery	D4260	$1,111	$1,500
Implant	D6010	$2,014	$2,250
Abutment for implant	D6057	$962	Not applicable
Crown for implant	D6066	$1,575	Not applicable
Pontic of bridge	D6240	$1,120	Not applicable
Crown retainer of bridge	D6750	$1,148	Not applicable

* The codes are established by the American Dental Association. They are recognized as the national terminology for reporting dental services in the United States. The codes D4341 and D4260 are for a quadrant.

adjusted for the number of teeth preserved at year 13, the range was $1,898 to $11,669. The cost to replace one tooth was determined to be $3,416 for a three-unit fixed bridge and $4,551 or $4,787 for a single-tooth replacement based on an implant fee (D6010) for a general dentist or periodontist, respectively. Figure 3A shows that the cost of periodontal treatment to preserve one tooth is less than the cost of a single-tooth replacement or a three-unit fixed bridge for a patient with severe CP plus high risk, moderate CP plus high risk, and moderate CP plus moderate risk. However, for a patient with mild CP plus moderate risk, the cost of periodontal treatment using general dentist fees to preserve one tooth is nearly the same as the cost of a single-tooth replacement but greater than the cost of a three-unit fixed bridge. For a patient with mild periodontitis plus low risk, the cost of periodontal treatment to preserve one tooth is much greater than the cost of a single-tooth replacement and a three-unit fixed bridge.

DISCUSSION

The economic model described by Fardal et al[1] was modified for this study to describe the cost of periodontal treatment associated with the benefit of tooth preservation. The present model, as was done by Fardal et al., limits the number of variable factors to produce a simple model that could be clearly explained. The present model produced results consistent with those of Fardal et al. while adding variables for CP severity and risk that increase its precision and establish a basis for more complex models that may have even greater precision and utility. The factors of the present model are nearly identical to those used by Fardal et al; key differences in the present model include the timeframe, teeth lost before periodontal maintenance, and categorizing patients by CP severity and risk.

The present model used a 13-year timeframe because of the study periods of the datasets. The dataset for the routine dental care group[15,16] had a 15-year study period, which could be adjusted to 13 years because tooth loss was linear over time.[20] The dataset for the periodontal treatment group had a mean study period of 13 years.[12] To comprehensively describe the benefit of tooth preservation, the present model counted all teeth lost from the inception of periodontal treatment. The present model categorized patients by CP severity and risk because they have been shown to be important factors for tooth loss.[12,16]

According to the present model, periodontal treatment is beneficial in a context of tooth preservation except when severity is mild and risk is low because the cost of periodontal treatment is greater than that to replace teeth lost because there was no periodontal treatment. However, neither study population included individuals to compare with severe CP plus moderate or low risk, moderate CP plus low risk, or mild CP plus high risk. Also, two severity and risk combinations included a small number of individuals (mild CP plus low or moderate risk). Much larger populations are required to assess the cost of treating CP associated with tooth preservation for the full range of severity and risk.

A reason why the cost adjusted for tooth preservation is so high for mild CP plus low risk is dividing the cost by 0.51 for teeth preserved is equivalent to multiplying the cost by two. In contrast, the cost adjusted for tooth preservation for severe CP plus high risk and moderate CP plus moderate or high risk is equivalent to multiplying the cost by one half.

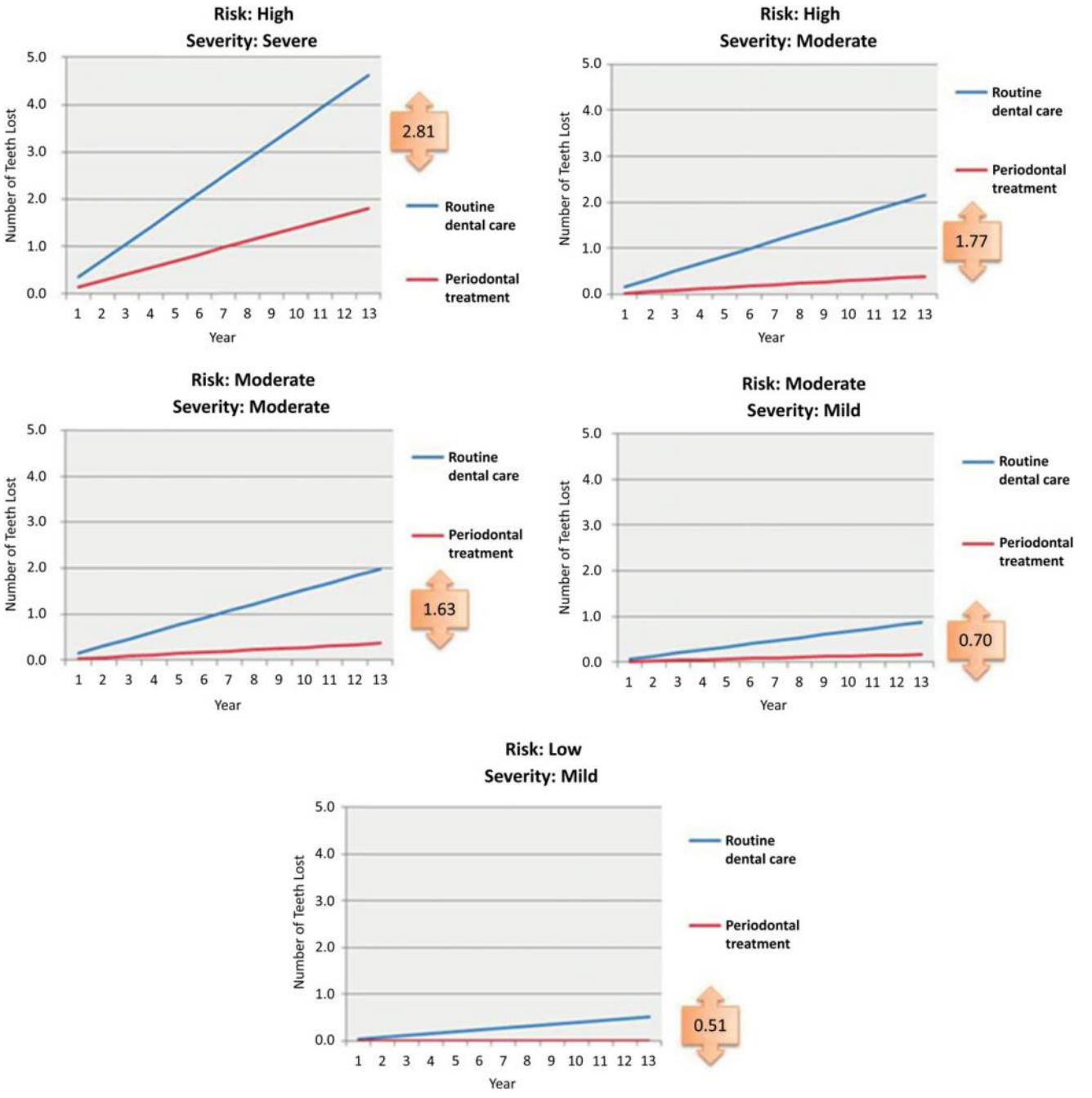


Figure 2.

Cumulative tooth loss for years 1 to 13 derived from annual average tooth loss for four categories of periodontitis severity plus risk. The net difference of tooth loss for routine dental care minus periodontal treatment is displayed in the orange boxes. Tooth loss was linear for patients of the routine dental care group and is presumed to be linear for patients of the periodontal treatment group. For groups 3 and 4 of the periodontal treatment population, the average annual tooth loss, 0.03, of group 2 was arbitrarily used instead of the actual value of 0.02 or 0.00 because each value was based on very few patients.

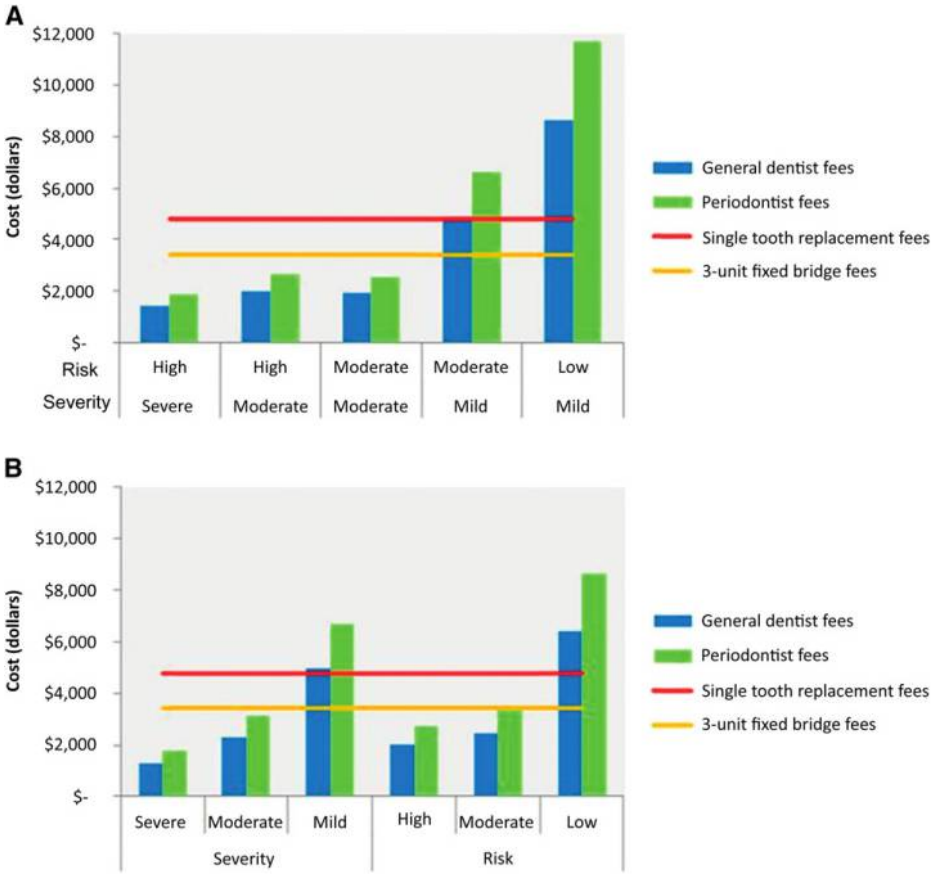


Figure 3.
The cost of periodontal treatment associated with the benefit of preserving one tooth for each combination of CP severity and risk using general dentist and periodontist fees. The value for each column was determined by dividing the cost of periodontal treatment by the number of teeth preserved for the appropriate CP severity and risk combination and fees of either a general dentist or periodontist. The horizontal red line is the cost to replace one tooth using a single-tooth replacement (one implant plus one implant abutment plus one crown). This cost is based on a periodontist's fee for an implant (D6010) and a general dentist's fee for an abutment (D6057) and crown (D6066). The horizontal orange line is the cost to replace one tooth using a three-unit fixed bridge (one pontic and two abutment crowns).

The specific treatment plan is another reason why the cost for tooth preservation is so high for mild CP plus low risk. For example, 3.40 quadrants of surgery were more than was applied for patients with severe CP. Although this may be an aberration of treatment typically applied, there were only five patients involved. Furthermore, the wellness or medical model of care suggests that a low-risk patient may not need surgery.[23,24] Substituting 4.00 for 2.40 quadrants of SRP and 0.00 for 3.40 quadrants of surgery results in a cost adjusted to preserve one tooth of $1,980 or $2,682, respectively, for a general dentist or periodontist. Accordingly, it is suggested that future research is needed to determine what periodontal treatment would be cost beneficial in a context of tooth preservation for each combination of severity and risk.

For mild CP, the tooth loss rate was less for periodontal treatment (e.g., 0.000 and 0.013) compared with routine dental care (e.g., 0.067 and 0.039). Hence, periodontal treatment when severity is mild may be preferred, although in the present study, it is not cost effective. Furthermore, this may suggest that initiating periodontal treatment when severity is mild can nearly eliminate tooth loss.

Because tooth loss for the routine dental care population diverged from the periodontal treatment population, the benefit of tooth preservation relative to treatment cost increases for time periods >13 years. This is consistent with the divergence of tooth loss over time shown in Figure 2. The yearly cost and benefit of tooth preservation for annual time periods was not calculated since data for this calculation was not included in the periodontal treatment dataset.[12] Future research that documents annual cost and tooth loss would enable development of a model that calculates tooth-years lost and incremental cost-effectiveness ratios.

Because general dentists and periodontists can provide periodontal treatment, their respective fees are included and, for the purpose of this study, it is presumed that the results attained by a general dentist would be equivalent to those attained by a periodontist.

Fees at the 80th percentile are used in the present study as a means to illustrate the results of the model. However, the effect of using fees for the 75th, 80th, 85th, 90th, and 95th percentiles was examined, and the results obtained were essentially the same as shown in Figure 3 because the relative difference among treatment fees at each percentile was nearly identical.

Limiting the scope of periodontal treatment interventions to SRP and osseous surgery may underestimate the full cost of periodontal treatment. Furthermore, the number of interventions used to

establish indicated treatment has not been substantiated by other studies, which means that the cost for periodontal treatment may be more or less than calculated by the model. An additional limitation of the model is not including costs for variables, such as repair or replacement of a prosthetic appliance, endodontic treatment associated with periodontal or prosthetic treatment, the percentage of teeth replaced, and tooth replacement with methods other than a three-unit bridge and single-tooth replacement.

An important limitation of this study is the all-male and predominantly non-Hispanic white composition of the VA DLS cohort, which may limit the ability to generalize these findings to females and more diverse populations. Another limitation is that VA DLS participants were self-selected volunteers in a long-term study of aging and health. That made them likely to be more health conscious and to practice better overall self-care, including oral self-care, than their peers. Thus, it is possible that, all else being equal, their likelihood of periodontal disease progression and tooth loss may be lower than in other community-dwelling adults. That is, a typical community cohort group with untreated periodontal disease may have worse outcomes than the untreated VA DLS participants. Hence, the present analysis may, at worst, be underestimating the true costs of leaving periodontal disease untreated.

The disparate time periods over which the data were collected for the two comparison groups and the groups' sex differences may also be considered limitations. The periodontal treatment group used data from both males and females treated from 1971 to 2003, whereas the untreated group used data from males followed over a 15-year period that ranged from 1968 to 1988.

The reliance of the present study on self-reported data on periodontal treatment in the VA DLS merits some discussion. Cognitive testing of similar self-report items indicates that such questions are conceptually well understood by respondents.[25] However, their accuracy remains limited. The validity of self-reports in the VA DLS cohort were previously investigated.[24] When using alveolar bone loss as the gold-standard measure for periodontal disease, it was found that self-reports of periodontal status and of previous periodontal treatment generally had high specificity but lower sensitivity.[26] Thus, it is likely that the 8% treatment prevalence in the VA DLS is an accurate lower bound estimate, but it is possible that many others did receive periodontal treatment but failed to recall it accurately. If so, that direction of misclassification, to the extent that it may exist, would bias the present results toward the null.

Despite the shortcomings of the present study, it is believed that incorporating severity and risk to the Fardal et al.[1] model is an important step forward in evaluating cost effectiveness and cost benefits of periodontal treatment in heterogeneous populations in terms of CP severity and risk. For example, the comparison of Figure 3A with 3B illustrates that combining severity and risk is more precise than severity or risk alone and Figure 1 illustrates the magnitude of severity and risk categories that could provide even greater precision. Additional variables that could be included in future economic models of periodontal disease and its treatment include effects of importance to the patient, such as halitosis, tooth mobility, sensitivity, and esthetics and effects related to cardiovascular disease, diabetes, and pregnancy.

CONCLUSIONS

Periodontal treatment could be justified on the sole basis of tooth preservation when CP risk is moderate or high regardless of disease severity. However, periodontal treatment when CP severity is mild may be preferred, although it might not be cost effective.

ACKNOWLEDGMENTS

Dr. Garcia was a recipient of a Veterans Affairs (VA) Career Development Award in Health Services Research from the VA Health Services Research and Development Service, Washington, DC. Dr. Garcia was also supported by National Institute of Dental and Craniofacial Research Grant K24 DE000419. The VA Dental Longitudinal Study and VA Normative Aging Study are components of the Massachusetts Veterans Epidemiology Research and Information Center, Boston, Massachusetts, which is supported by the Department of Veterans Affairs Cooperative Studies Program. PreViser, Mt. Vernon, Washington, funded this study. Dr. Martin owns equity and is the chief science officer at PreViser. He has also received consulting fees from PreViser. Dr. Page owns equity in PreViser. Dr. Loeb also owns stock in PreViser and serves as its chief executive officer. Drs. Fardal and Linden report no conflicts of interest related to this study. Drs. Garcia and Dr. Kaye do not have any commercial relationships to report, nor do they have any conflicts of interest related to this study.

REFERENCES

1. Fardal Ø, O'Neill C, Gjermo P, et al. The lifetime direct cost of periodontal treatment: A case study from a Norwegian specialist practice. *J Periodontol* 2012; 83:1455-1462.
2. Fardal Ø, Johannessen AC, Linden GJ. Tooth loss during maintenance following periodontal treatment in

a periodontal practice in Norway. *J Clin Periodontol* 2004;31:550-555.
3. Axelsson P, Lindhe J, Nyström B. On the prevention of caries and periodontal disease. Results of a 15-year longitudinal study in adults. *J Clin Periodontol* 1991;18: 182-189.
4. Goldman MJ, Ross IF, Goteiner D. Effect of periodontal therapy on patients maintained for 15 years or longer. A retrospective study. *J Periodontol* 1986;57: 347-353.
5. McLeod DE, Lainson PA, Spivey JD. The effectiveness of periodontal treatment as measured by tooth loss. *J Am Dent Assoc* 1997;128:316-324.
6. Nabers CL, Stalker WH, Esparza D, Naylor B, Canales S. Tooth loss in 1535 treated periodontal patients. *J Periodontol* 1988;59:297-300.
7. Wilson TG Jr., Glover ME, Malik AK, Schoen JA, Dorsett D. Tooth loss in maintenance patients in a private periodontal practice. *J Periodontol* 1987;58: 231-235.
8. Hirschfeld L, Wasserman B. A long-term survey of tooth loss in 600 treated periodontal patients. *J Periodontol* 1978;49:225-237.
9. Wood WR, Greco GW, McFall WT Jr. Tooth loss in patients with moderate periodontitis after treatment and long-term maintenance care. *J Periodontol* 1989; 60:516-520.
10. McFall WT Jr. Tooth loss in 100 treated patients with periodontal disease. A long-term study. *J Periodontol* 1982;53:539-549.
11. Tonetti MS, Muller-Campanile V, Lang NP. Changes in the prevalence of residual pockets and tooth loss in treated periodontal patients during a supportive maintenance care program. *J Clin Periodontol* 1998;25: 1008-1016.
12. Martin JA, Page RC, Loeb CF, Levi PA Jr. Tooth loss in 776 treated periodontal patients. *J Periodontol* 2010; 81:244-250.
13. Kornman KS. Mapping the pathogenesis of periodontitis: A new look. *J Periodontol* 2008;79(Suppl. 8):1560-1568.
14. Gilbert GH, Shelton BJ, Chavers LS, Bradford EH Jr. Predicting tooth loss during a population-based study: Role of attachment level in the presence of other dental conditions. *J Periodontol* 2002;73:1427-1436.
15. Page RC, Krall EA, Martin JA, Mancl LA, Garcia RI. Validity and accuracy of a risk calculator in predicting periodontal disease. *J Am Dent Assoc* 2002;133:569-576.
16. Martin JA, Page RC, Kaye EK, Hamed MT, Loeb CF. Periodontitis severity plus risk as a tooth loss predictor. *J Periodontol* 2009;80:202-209.
17. Eke PI, Dye BA, Wei L, Thornton-Evans GO, Genco RJ; CDC Periodontal Disease Surveillance workgroup. Prevalence of periodontitis in adults in the United States: 2009 and 2010. *J Dent Res* 2012;91:914-920.
18. Fardal Ø, Linden GJ. Tooth loss and implant outcomes in patients refractory to treatment in a periodontal practice. *J Clin Periodontol* 2008;35:733-738.
19. Page RC, Martin JA. Quantification of periodontal risk and disease severity and extent using the oral health information suite (OHIS). *Periodontal Pract Today* 2007;4:163-180.
20. Page RC, Martin J, Krall EA, Mancl L, Garcia R. Longitudinal validation of a risk calculator for periodontal disease. *J Clin Periodontol* 2003;30:819-827.
21. Kapur KK, Glass RL, Loftus ER, Alman JE, Feller RP. The Veterans Administration longitudinal study of oral health and disease. *Int J Aging Hum Dev* 1972;3:125-137.
22. American Dental Association 2011 Survey of Dental Fees. Available at: https://www.ada.org/members/sections/professionalResources/11_sdf.pdf. Accessed February 1, 2013.
23. Beck JD. Methods of assessing risk for periodontitis and developing multifactorial models. *J Periodontol* 1994;65(Suppl. 5):468-478.
24. Page RC, Martin JA, Loeb CF. The Oral Health Information Suite (OHIS): Its use in the management of periodontal disease. *J Dent Educ* 2005;69:509-520.
25. Miller K, Eke PI, Schoua-Glusberg A. Cognitive evaluation of self-report questions for surveillance of periodontitis. *J Periodontol* 2007;78(Suppl. 7):1455-1462.
26. Pitiphat W, Garcia RI, Douglass CW, Joshipura KJ. Validation of self-reported oral health measures. *J Public Health Dent* 2002;62:122-128.

Correspondence: Dr. John A. Martin, 2521 Carnegie Dr., State College, PA 16803. E-mail: johnm@previser.com.

Submitted April 10, 2013; accepted for publication August 2, 2013.