Published in final edited form as:

J Evid Based Dent Pract. 2015 December ; 15(4): 171–181. doi:10.1016/j.jebdp.2015.10.001.

Appropriate Recall Interval for Periodontal Maintenance: A Systematic Review

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Abstract

Objectives—A systematic review of the literature was undertaken to assess the evidence to support a specific time interval between periodontal maintenance (PM) visits.

Methods—Relevant articles were identified through searches in MEDLINE, EMBASE and PubMed using specific search terms, until April, 2014, resulting in 1095 abstracts and/or titles with possible relevance. Critical Appraisal Skills Programme (CASP) guidelines were used to evaluate the strength of studies and synthesize findings. If mean recall interval was not reported for study groups, authors were contacted to attempt to retrieve this information.

Results—Eight cohort studies met the inclusion criteria. No randomized control trials were found. All included studies assessed the effect of PM recall intervals in terms of compliance with a recommended regimen (3–6 months) as a primary outcome. Shorter PM intervals (3–6 months) favored more teeth retention but also statistically insignificant differences between RC and IC/EC, or converse findings are also found. In the 2 studies reporting mean recall interval in groups, significant tooth loss differences were noted as the interval neared the 12 month limit.

Conclusions—Evidence for a specific recall interval (e.g. every 3 months) for all patients following periodontal therapy is weak. Further studies, such as RCTs or large electronic database evaluations would be appropriate. The merits of risk-based recommendations over fixed recall interval regimens should be explored.

Keywords

Periodontal diseases; Periodontal maintenance; Supportive periodontal therapy; Dental prophylaxis; Tooth loss; Systematic review; Patient compliance

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Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.jebdp.2015.10.001>.

INTRODUCTION

Periodontal Maintenance (PM) is defined by the American Academy of Periodontology Glossary of Periodontal Terms, 2001¹ (4th edition) as “Procedures performed at selected intervals to assist the periodontal patient in maintaining oral health.” It includes an update of the medical and dental histories, radiographic review, extraoral and intraoral soft and hard tissue examination, periodontal evaluation, removal of the bacterial flora from crevicular and pocket areas, scaling and root planing where indicated, polishing of the teeth, and a review of the patient's plaque control efficacy. It is further explained that as part of periodontal therapy,¹ “an interval is established for periodic ongoing care.”

Many studies have highlighted the importance of PM. Among the most well-known are Hirschfield and Wasserman,² McFall,³ Lindhe and Nyman,⁴ Wilson et al.,⁵ and Goldman et al.⁶ These studies evaluated effects of PM procedures on tooth loss/retention, and were among the first to contribute to the body of evidence on this subject.

Recent studies strengthen the case for PM. Fardal et al.⁷ evaluated 100 consecutive patients who had received comprehensive periodontal therapy and then followed them for 9–11 years of PM. The study showed that regular maintenance after periodontal treatment is associated with low levels of tooth loss. With regards to the interval between periodontal maintenance visits, there is a wide range of recommended periods in the published literature, including 2 weeks,^{8,9} 2–3 months,¹⁰ 3 months,^{11–15} 3–4 months,^{16,17} 3–6 months,¹⁸ and even as long as 18 months.¹⁹

Establishing appropriate PM intervals helps assure timely follow-up, decreased disease recurrence and improved resource utilization. This systematic review of the literature was undertaken to evaluate the evidence regarding the most appropriate time interval for PM, for patients previously treated for chronic periodontal disease.

METHODS

We utilized the PICO (population, intervention, comparison, and outcome) approach to formulate the parameters for article inclusion in this review:

Population

Adults with a verified periodontal disease diagnosis, i.e., diagnosis of the disease should be consistent with the definition according to the 1999²⁰ International workshop for Classification of Periodontal Disease and Conditions.

Intervention Exposures

Periodontal maintenance. Studies should have defined PM procedures, and should be consistent with the broad understanding of supportive periodontal therapy undertaken after successful active periodontal therapy.

Comparison

Varying intervention frequencies.

Outcomes

- 1) Maintenance of Periodontal Attachment. Clinical Attachment Level.
- 2) Tooth retention.
- 3) Patient-based assessments of periodontal health.

(At least one of the above must be part of the measured outcomes in a study.)

Using the PICO question, a literature search was conducted in MEDLINE (MJ and CW) and EMBASE (MJ) under the guidance of library scientists (March 2011), with updates of this search set to run every 2 weeks in MEDLINE (up to April 2014). The details of these search strategies are presented in the Appendix 1. An additional search was performed (OF) in PubMed, (March 2011 and April 2014) using the terms “supportive periodontal therapy” and “periodontal maintenance.” These searches resulted in a total of 1095 articles (Figure 1).

Thirty articles were selected for Phase I review, with eight of these articles meeting the criteria of the PICO question for inclusion in the final review. All eight studies were retrospective cohort studies.

Review Process—In the Phase I assessment, the studies were screened to assure each met the following criteria:

- Study population solely or primarily adults.
- Definition of the level of periodontal disease within the study population. Inclusion of description of time intervals between periodontal maintenance visits.
- Inclusion of at least one of the three outcomes described in the PICO parameters.

(Phase I Assessment Form: Appendix 2).

The Phase II assessment utilized the Critical Appraisal Skills Programme (CASP) protocol²¹ for the eight identified articles from Phase I. The CASP (2004) worksheet contained 12 questions that included assessment of the study's specific and clearly defined objectives; design and statistical methods; and the validity, relevance and applicability of the results to our PICO question (see Phase II form, Appendix 3). A newer (2013) version of the form²¹ is now available online. Each of the five reviewers (OF, CW, GG, MJ, JJ) independently evaluated each of the eight studies. Following a group discussion, a single consensus rating was agreed upon for each study, resulting in a rating of Excellent, Good, Fair or Poor. In the final phase, a data extraction form was used (shown as Table 1) to synthesize important findings of all studies that met the inclusion criteria. Table 1 includes the assigned consensus ratings by reviewers, characteristics of study population, study location, prescribed frequency of periodontal maintenance (when available), cohort description, study design, outcomes and covariates. Mean annual tooth loss over the course of Periodontal Maintenance is included, if reported in the study; otherwise, average tooth loss per patient

over the course of the study is documented. All corresponding authors that did not include a mean recall interval per study group were contacted for possible clarification.

RESULTS

The electronic search as described above resulted in a final tally of 1095 abstracts and/or titles (Figure 1). Of the 1095 abstracts and titles, 30 articles were selected for Phase I review by two reviewers (OF, GG). Of these, 8 articles met the criteria of the PICO parameters for inclusion in the Phase II review. There were no randomized controlled trials or cohort studies that directly compared different time intervals between PM visits, on periodontal parameters and/or tooth loss. The 8 studies included in the final review assessed how level of compliance with the suggested PM regimen affects tooth retention (final outcome). Considerable heterogeneity existed among the studies (see Table 1). The differences precluded any possibility of direct comparisons between studies. The prescribed PM recall in included studies varied from 3 to 6 months. Using CASP criteria we rated through consensus, the quality and strength of one study as Excellent (Ng et al.),²² three studies as Good (Costa et al.,²³ Miyamoto et al.,²⁴ Tsami et al.²⁵), two as Fair (Checchi et al.,²⁶ Wilson et al.²⁷) and two as Poor (Seirafi et al.,²⁸ Wood, et al.²⁹). Table 1 provides the specific details for each article.

The Three Noteworthy Findings are Summarized Below

Appropriate interval for PM recall was not addressed as a specific outcome in any of the studies. Costa et al.²³ noted that compliers had an average recall of 5.5 months and non-compliers were seen an average of every 11.6 months. There was a significant increase in tooth loss in non-compliers compared to compliers. Through correspondence with Ng et al.,²² it was noted that “regular compliers” were seen an average of every 4.4 months and “irregular compliers” were seen every 6.7 months on average. In this study there was no significant difference between compliers and irregular compliers. Three other authors responded to our request, stating they could not provide the average recall interval for their study groups.

Finding #1: More Frequent PM Recall Visits (3–6 Month) = Fewer Teeth

Extracted—In Costa et al.²³ persons who attended PM visits on average, every 5.5 months for the study duration of 5 years (Regular compliers) had mean annual tooth loss per patient of 0.12 teeth. Persons with a PM visit on average every 11.6 months (Irregular compliers), had mean annual tooth loss per patient of 0.36. Checchi et al.,²⁶ reported that those who returned for PM interval less than every 3–4 months were 5.6 times more likely to lose teeth (CI 1.90–16.3).

Finding #2: No (Statistically) Significant Difference Between Tooth Loss With PM Interval <6 and >6 Months—

As noted above, Ng, et al.²² reported no statistically significant difference between tooth loss in Regular Compliers (RC) – Mean interval every 4.4 months and Irregular Compliers (IC), the mean interval – every 6.7 months. No statistical difference between RC (PM interval 3–6 months) and IC (>6 months) was also reported by Seirafi et al.²⁸

Finding #3: More Frequent PM Interval (Every 3–4 Months) = More Teeth

Extracted—Miyamoto et al.²⁴ reported that those who attended at least 70% of 3–4 monthly PM visits were significantly more likely to lose teeth than those who attended less than 70% ($p < 0.001$). The authors hypothesized that patients who are highly compliant to prescribed PM are also likely to have a higher rate of acceptance of proposed dental treatment. This proposed treatment, according to the authors might have been influenced by “current changes in treatment planning, better understanding of the prognosis of the dentition, and significant improvement in the success rate of dental implants.” Using the study’s reported Compliance Model II, those with a 2 year interval of absenteeism from PM had no significant tooth loss difference with the complete compliers (see Table 1, for definition of compliance models and related details).

DISCUSSION

In contrast to the general population without a history of periodontal disease, patients previously treated for chronic periodontitis appear to require a more frequent recall system (Periodontal maintenance). Otherwise, progressive loss of periodontal attachment may^{30–32} occur. Kocher et al. suggested³³ that “systematic periodontal treatment stops interdental bone loss and decreases the rate of tooth loss in most cases. Periodontal surgery without regular follow-up care cannot prevent further periodontal destruction, but it can delay it.”

The main focus of many of the earlier studies^{2,4,6,33,34} was to evaluate the effectiveness of periodic oral prophylaxes after periodontal surgical or non-surgical therapies. It is clear that periodontal maintenance or supportive periodontal therapy after active therapy is needed; however, data to support a specific PM frequency for best possible outcomes are not robust. Other notable studies^{2,4,6} only indirectly broached the subject of optimum PM recall intervals without comparing PM time intervals. A systematic review in 2013, not limited to periodontal patients, found only a single RCT³⁵ that met their inclusion criteria. The conclusion was that it did not provide any strong evidence to support or refute a fixed dental recall interval for clinical examination. A meta-analysis by Beirne et al. (2007)³⁶ also found insufficient evidence to show any beneficial or adverse effects of routine scaling and polishing for periodontal health provided at different time intervals.

The American Academy of Periodontology’s position paper on the subject of Periodontal Maintenance³⁷ stated that for “most patients with a history of periodontitis, visits at every 3-month interval may be required initially.” It is further explained that this “will result in decreased likelihood of progressive disease compared to patients receiving PM on a less frequent basis.” The position paper cited published studies^{10,38–41} in support of this statement. These earlier studies did provide definitive information related to the frequency required to instrument teeth (for maintenance of periodontal health) after active therapy. However, none aimed to compare efficacy of different PM time intervals. In Axelsson and Lindhe (1981),¹⁰ the participants in the *Recall* group attended PM every 2–3 months. The participants in *Non-Recall* group, after active periodontal therapy, were sent back to the referring dentist and were recalled only for examination at 3 and 6 years. PM if received elsewhere by the participants in that group was not reported. Ramfjord et al. (1987)³⁹ studied four modalities of periodontal therapy, and did not discuss PM. In Axelsson, Lindhe

(1978)⁴⁰ participants in the *Test Group* received oral hygiene instructions (OHI). The dental prophylaxis including scaling/root planing was done every 2 months in the first 2 years and then every 3 months in the third year. The *Control Group* (as stated in the article) “merely received symptomatic treatment” with no OHI and no dental prophylaxes. The study-findings support the importance of OHI included as part of PM but it might be a stretch to use this one to recommend PM “at four times per year,” over a less frequent, yet same PM procedure. These differences in the type of interventions between the study groups also make the other cited article by Axelsson, Lindhe, (1981)⁴¹ inapplicable as the basis of appropriate recall interval. The last cited article in the position paper by Haffajee et al. (1991),³⁸ did not discuss PM. Additionally, none of these studies accounted for what we now know as well established chronic periodontal disease risk factors, i.e., history of smoking and diabetes. The AAP position paper, though, remarked on the need to “individualize the PM schedules, according to the needs of the patients;” it could not provide adequate evidence based guidelines on how a variable PM regimen may be determined.

A fixed recall interval, such as every 6 months, for all dental patients was first questioned by Sheiham⁴² in 1977. After many years, other studies appeared in the literature^{43,44} highlighting the scant evidence to support bi-annual recall visits. For periodontal maintenance, it is also established that the risk of clinical attachment breakdown is not fixed or absolute. It varies in different teeth and in different individuals.^{45,46}

Interestingly, the effect of PM recall interval on periodontal health has been studied in the past (and in the included studies in this review) from the standpoint of compliance to a specified PM interval. It appears that there is a reasonable need to research further the very basis of such a suggested interval. An increasing number of studies^{47–51} have highlighted the importance of utilizing risk-based models to identify patients at higher risk with some promising developments being made in this arena. The Periodontal Risk Calculator (PRC) was introduced⁴⁷ by Page et al. Based on mathematically derived algorithms it assigns relative weights to the various known risks that may increase patients’ susceptibility to develop periodontitis. PRC scores were shown in the study⁴⁷ to be strong predictors for the periodontal status as measured by the alveolar bone loss of periodontally affected teeth.

Another tool described by Lang and Tonetti⁴⁹ as Periodontal Risk Assessment (PRA) is of some relevance here. Using known risk factors/indicators in each individual patient, it aims to enable the practitioner to determine the frequency and extent of professional support necessary to maintain periodontal health following active therapy.

A recent systematic review showed that 6 out of 7 cohort studies using PRA and its modifications may be a valid predictive tool for periodontitis progression and tooth loss.⁵¹ The successful application of risk assessment tools in research is thus quite promising. Future work may see refinement in technology that will further utilize and incorporate such tools with advanced electronic (dental) health records systems. This may make PM recall interval decisions more patient-centered than the currently prevalent ‘one size fits all’ model.

Large data sets utilizing electronic health records have the potential to help answer the question regarding outcomes during varying recall intervals. A more evidence based and

customizable approach in suggesting a recall interval, perhaps may also contribute in improving compliance. Prospective assessment of cohort data can include medical and other dental variables that would help refine the specific patient populations that may require more frequent or appropriately prolonged PM interval.

Limitations of This Review

Limitations of this systematic review include:

1. No published randomized controlled trials (RCTs) were found on this subject.
2. No studies directly compared different recall intervals, and effect on periodontal health parameters or tooth loss. In general studies did not consistently or clearly define the frequency or time period between PM visits, observed for regular, erratic, or irregular compliers. For example, in the study by Wilson et al.²⁷ which was included in our review (Table 1) any participant who did not comply with the suggested PM recall regimen fell in this broadly-defined “erratic” group, with noncompliance ranging between 8 and 80%. We made the attempt to contact all lead or corresponding authors of the included studies in this review; when contact information were available. Specifically we requested, if known, mean PM recall interval for complete and irregular/erratic compliers and non-compliers. Such data is reported in Table 1, when made available to us by the authors.
3. With the exception of one study by Ng et al.,²² none had data on non-compliers.
4. Study designs and recommended PM recall regimen were also not uniform. Co-morbidities, and report on potential recall bias (such as patients who attend PM regularly may also be more motivated to maintain good home care between visits), were not clearly explained.

CONCLUSIONS

Within limits of our review, we conclude that there is weak evidence to support a fixed and specific PM recall interval (e.g. every 3 months) or evidence of a threshold interval after which tooth loss is significantly higher. Limited evidence appears to favor more frequent PM recall visits but the optimum frequency is unclear. A ‘one size fits all’ type of recommendation may be questionable, as the focus of future research shifts to risk based assessments. Randomized control trials with standardized designs and large longitudinal cohort studies with varying recall intervals, are needed to evaluate the effects of varying time intervals on the stability of the periodontium, while accounting for risk assessment and co-morbidities. Appropriate recall intervals may also then become more evidence based and customizable.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

REFERENCES

1. American Academy of Periodontology. Glossary of Periodontal Terms. 4th ed.. American Academy of Periodontology; Chicago: 2001. p. 39
2. Hirschfeld L, Wasserman B. A long-term survey of tooth loss in 600 treated periodontal patients. *J Periodontol.* May; 1978 49(5):225–37. [PubMed: 277674]
3. McFall WT Jr. Tooth loss in 100 treated patients with periodontal disease. A long-term study. *J Periodontol.* Sep; 1982 53(9):539–49. [PubMed: 6957591]
4. Lindhe J, Nyman S. Long-term maintenance of patients treated for advanced periodontal disease. *J Clin Periodontol.* Sep; 1984 11(8):504–14. [PubMed: 6384275]
5. Wilson TG Jr, Glover ME, Schoen J, Baus C, Jacobs T. Compliance with maintenance therapy in a private periodontal practice. *J Periodontol.* Aug; 1984 55(8):468–73. [PubMed: 6384465]
6. Goldman MJ, Ross IF, Goteiner D. Effect of periodontal therapy on patients maintained for 15 years or longer. A retrospective study. *J Periodontol.* Jun; 1986 57(6):347–53. [PubMed: 3522850]
7. Fardal Ø, Johannessen AC, Linden GJ. Tooth loss during maintenance following periodontal treatment in a periodontal practice in Norway. *J Clin Periodontol.* Jul; 2004 31(7):550–5. [PubMed: 15191591]
8. Nyman S, Rosling B, Lindhe J. Effect of professional tooth cleaning on healing after periodontal surgery. *J Clin Periodontol.* Apr; 1975 2(2):80–6. [PubMed: 1094035]
9. Rosling B, Nyman S, Lindhe J, Jern B. The healing potential of the periodontal tissues following different techniques of periodontal surgery in plaque-free dentitions. A 2-year clinical study. *J Clin Periodontol.* Nov; 1976 3(4):233–50. [PubMed: 1069012]
10. Axelsson P, Lindhe J. The significance of maintenance care in the treatment of periodontal disease. *J Clin Periodontol.* Aug; 1981 8(4):281–94. [PubMed: 6947992]
11. Knowles JW, Burgett FG, Nissle RR, Shick RA, Morrison EC, Ramfjord SP. Results of periodontal treatment related to pocket depth and attachment level. Eight years. *J Periodontol.* May; 1979 50(5):225–33. [PubMed: 287778]
12. Ramfjord SP, Knowles JW, Nissle RR, Burgett FG, Shick RA. Results following three modalities of periodontal therapy. *J Periodontol.* Sep; 1975 46(9):522–6. [PubMed: 1057645]
13. Fleszar TJ, Knowles JW, Morrison EC, Burgett FG, Nissle RR, Ramfjord SP. Tooth mobility and periodontal therapy. *J Clin Periodontol.* Dec; 1980 7(6):495–505. [PubMed: 6938529]
14. Becker W, Becker BE, Ochsenein C, et al. A longitudinal study comparing scaling, osseous surgery and modified Widman procedures. Results after one year. *J Periodontol.* Jun; 1988 59(6): 351–65. [PubMed: 3292752]
15. Ramfjord SP, Knowles JW, Nissle RR, Shick RA, Burgett FG. Longitudinal study of periodontal therapy. *J Periodontol.* Feb; 1973 44(2):66–77. [PubMed: 4509540]
16. Suomi JD, Greene JC, Vermillion JR, Doyle J, Chang JJ, Leatherwood EC. The effect of controlled oral hygiene procedures on the progression of periodontal disease in adults: results after third and final year. *J Periodontol.* Mar; 1971 42(3):152–60. [PubMed: 4396693]
17. Pihlstrom BL, McHugh RB, Oliphant TH, Ortiz-Campos C. Comparison of surgical and nonsurgical treatment of periodontal disease. A review of current studies and additional results after 61/2 years. *J Clin Periodontol.* Sep; 1983 10(5):524–41. [PubMed: 6355204]
18. Bostanci HS, Arpak MN. Long-term evaluation of surgical periodontal treatment with and without maintenance care. *J Nihon Univ Sch Dent.* Sep; 1991 33(3):152–9. [PubMed: 1748885]
19. Rosén B, Olavi G, Badersten A, Rönström A, Söderholm G, Egelberg J. Effect of different frequencies of preventive maintenance treatment on periodontal conditions. 5-year observations in general dentistry patients. *J Clin Periodontol.* Apr; 1999 26(4):225–33. [PubMed: 10223393]
20. Ann Periodontol; 1999 International Workshop for a Classification of Periodontal Diseases and Conditions. Papers; Oak Brook, Illinois. October 30–November 2, 1999; Dec. 1999 p. ip. 1–112. submitted for publication
21. [02.09.14] Critical Appraisal Skills Programme. http://media.wix.com/ugd/dded87_951541699e9edc71ce66c9bac4734c69.pdf;

22. Ng MC, Ong MM, Lim LP, Koh CG, Chan YH. Tooth loss in compliant and non-compliant periodontally treated patients: 7 years after active periodontal therapy. *J Clin Periodontol.* 2011; 38:499–508. [PubMed: 21342213]
23. Costa FO, Lages EJ, Cota LO, Lorentz TC, Soares RV, Cortelli JR. Tooth loss in individuals under periodontal maintenance therapy: 5-year prospective study. *J Periodont Res.* 2014; 49:121–8. [PubMed: 23647520]
24. Miyamoto T, Kumagai T, Jones JA, Van Dyke TE, Nunn ME. Compliance as a prognostic indicator: retrospective study of 505 patients treated and maintained for 15 years. *J Periodontol.* 2006; 77:223–32. [PubMed: 16460248]
25. Tsami A, Eudoxie P, Kodvazenitis G, Komboli M. Parameters affecting tooth loss during periodontal maintenance in a Greek population. *J Am Dent Assoc.* 2009; 140(9):1100–7. [PubMed: 19723942]
26. Checchi L, Montevicchi M, Gatto MR, Trombelli L. Retrospective study of tooth loss in 92 treated periodontal patients. *J Clin Periodontol.* 2002; 29:651–6. [PubMed: 12354091]
27. Wilson TG, Glover ME, Malik AK, Schoen JA, Dorsett D. Tooth loss in maintenance patients in a private periodontal practice. *J Periodontol.* 1987; 58(4):231–5. [PubMed: 3295181]
28. Seirafi AH, Ebrahimi R, Golkari A, Khosropanah H, Soolari A. Tooth loss assessment during periodontal maintenance in erratic versus complete compliance in a periodontal private practice in Shiraz, Iran: a 10-year retrospective study. *J Int Acad Periodontol.* 2014; 16(2):43–9. [PubMed: 24844027]
29. Wood WR, Greco GW, McFall WT. Tooth loss in patients with moderate periodontitis after treatment and long-term maintenance care. *J Periodontol.* 1989; 60:516–20. [PubMed: 2677303]
30. Axelsson P, Nyström B, Lindhe J. The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. *J Clin Periodontol.* 2004; 31:749–57. [PubMed: 15312097]
31. Rosling B, Nyman S, Lindhe J. The effect of systematic plaque control on bone regeneration in infrabony pockets. *J Clin Periodontol.* 1976; 3:38. [PubMed: 767366]
32. Becker W, Becker BE, Berg LE. Periodontal treatment without maintenance. A retrospective study in 44 patients. *J Periodontol.* 1984; 55:505–9. [PubMed: 6592322]
33. Kocher T, König J, Dzierzon U, Sawaf H, Plagmann HC. Disease progression in periodontally treated and untreated patients – a retrospective study. *J Clin Periodontol.* 2000; 27(11):866–72. [PubMed: 11073331]
34. Lindhe J, Westfelt E, Nyman S, Socransky SS, Haffajee AD. Long-term effect of surgical/non-surgical treatment of periodontal disease. *J Clin Periodontol.* Aug; 1984 11(7):448–58. [PubMed: 6378986]
35. Riley P, Worthington HV, Clarkson JE, Beirne PV. Recall intervals for oral health in primary care patients. *Cochrane Database Syst Rev.* Dec.2013 19(12):CD004346. <http://dx.doi.org/10.1002/14651858.CD004346.pub4>. [PubMed: 24353242]
36. Beirne P, Worthington HV, Clarkson JE. Routine scale and polish for periodontal health in adults. *Cochrane Database Syst Rev.* Oct 17.2007 (4):CD004625. Review. [PubMed: 17943824]
37. Cohen RE. Research, Science and Therapy Committee, American Academy of Periodontology. Position paper: periodontal maintenance. *J Periodontol.* Sep; 2003 74(9):1395–401. [PubMed: 14584877]
38. Haffajee AD, Socransky SS, Smith C, Dibart S. Relation of baseline microbial parameters to future periodontal attachment loss. *J Clin Periodontol.* Nov; 1991 18(10):744–50. [PubMed: 1661304]
39. Ramfjord SP, Caffesse RG, Morrison EC, et al. Four modalities of periodontal treatment compared over five years. *J Periodont Res.* May; 1987 22(3):222–3. [PubMed: 2955103]
40. Axelsson P, Lindhe J. Effect of controlled oral hygiene procedures on caries and periodontal disease in adults. *J Clin Periodontol.* May; 1978 5(2):133–51. [PubMed: 275282]
41. Axelsson P, Lindhe J. Effect of controlled oral hygiene procedures on caries and periodontal disease in adults. Results after 6 years. *J Clin Periodontol.* Jun; 1981 8(3):239–48. [PubMed: 6947990]
42. Sheiham A. Is there a scientific basis for six-monthly dental examinations? *Lancet.* 1977; 2:442–4. [PubMed: 70653]

43. Rosén B, Olavi G, Birkhed D, Edvardsson S, Egelberg J. Effect of different frequencies of preventive maintenance treatment on dental caries: five-year observations in general dentistry patients. *Acta Odontol Scand*. Oct; 2004 62(5):282–8. [PubMed: 15841817]
44. Patel S, Bay RC, Glick M. A systematic review of dental recall intervals and incidence of dental caries. *J Am Dent Assoc*. 2010; 141:527–39. [PubMed: 20436100]
45. Clarkson JE, Amaechi BT, Ngo H, Bonetti D. Recall, reassessment and monitoring. *Monogr Oral Sci*. 2009; 21:188–98. <http://dx.doi.org/10.1159/000224223>. Epub 2009 Jun 3. Review. [PubMed: 19494686]
46. Rosling B, Serino G, Hellstrom MK, Socransky SS, Lindhe J. Longitudinal periodontal tissue alterations during supportive therapy. Findings from subjects with normal and high susceptibility to periodontal disease. *J Clin Periodontol*. 2001; 28:241–9. [PubMed: 11284537]
47. Page RC, Krall EA, Martin J, Mancil L, Garcia RI. Validity and accuracy of a risk calculator in predicting periodontal disease. *J Am Dent Assoc*. May; 2002 133(5):569–76. [PubMed: 12036161]
48. Lang NP, Tonetti MS. Periodontal risk assessment (PRA) for patients in supportive periodontal therapy (SPT). *Oral Health Prev Dent*. 2003; 1:7–16. [PubMed: 15643744]
49. Costa FO, Cota LO, Lages EJ, et al. Periodontal risk assessment model in a sample of regular and irregular compliers under maintenance therapy: a 3-year prospective study. *J Periodontol*. Mar; 2012 83(3):292–300. <http://dx.doi.org/10.1902/jop.2011.110187>. [PubMed: 21692626]
50. Teich ST. Risk Assessment-Based Individualized Treatment (RABIT): a comprehensive approach to dental patient recall. *J Dent Educ*. Apr; 2013 77(4):448–57. [PubMed: 23576590]
51. Lang NP, Suvan JE, Tonetti MS. Risk factor assessment tools for the prevention of periodontitis progression a systematic review. *J Clin Periodontol*. Apr; 2015 42(suppl 16):S59–S70. <http://dx.doi.org/10.1111/jcpe.12350>. [PubMed: 25496279]

Figure 1.
Flow of information through different phases of systematic review.

TABLE 1

Periodontal Maintenance (PM) Studies meeting PICO question criteria.

Study	Overall rating ^a	Population N & location	Prescribed PM	Cohorts	Design	Outcomes & covariates
Ng MCH et al., J Clin Periodontol, 2011 ²²	Excellent	N = 312 A Singapore government funded dental clinic. Completed APT; In maintenance 7 yrs. Diabetes mellitus: 8.6% Male: 41.35% Mean age: 44.7-49.3 years Periodontal status: Mild - 20.5% Mod - 67.6% Severe - 11.8%	Not published Written communication with author reveals: RC = Mean 2.7 PM visits/year (with approximate frequency of every 4.4 months) IC = Mean 1.8 PM visits/year (with approximate PM frequency of every 6.7 months)	All compliers (AC): n = 273 Regular compliers (RC): Attended 2/3 of appointments; n = 239 Irregular compliers (IC): Attended <2/3 of appointments; n = 34 Non-compliers (NC): Recalled from a pool of patients who completed APT, but did not utilize PM; n = 39 Exclusions: 1. Incomplete dental records 2. Systemic issues 3. PM in past	1. Retrospective cohort study: Chart review and radiographic evaluation to gather data, including reasons for teeth extraction. 2. Cross sectional study: Patients who underwent APT and did not undergo PM.	Outcomes: 1. Mean annual tooth loss/patient AC: 0.09 RC: 0.09 IC: 0.08 NC: 0.29 2. Reasons of tooth loss was also recorded as an outcome. Covariates: 1. Age 2. Gender 3. Smoking 4. Diabetes 5. Type of APT 6. Periodontal status before APT 7. Compliance
Costa et al., J Periodontal Res., 2014 ²³ (Note: certain calculations and figures were confirmed via correspondence with the authors.)	Good	N = 212 Patients from a single private dental clinic in Brazil. • Age: 18-66 years; • Good general health; • Completed active periodontal therapy; • Diagnosis chronic moderate to advanced periodontal disease before therapy; • Completed therapy 4 months before enrollment; • Presence of 14 teeth required for each participant. Homogenous sample, no differences at baseline except gender.	Max interval = 6 months between recall visits.	Regular compliers: • N = 96 • Average 11.2 visits in 61.2 months = average, 5.5 months of recall interval; • Included 100% MT compliant patients; • Max interval = 6 months. Irregular compliers: • N = 116 • Average 5.4 visits in 62.6 months = average, 11.6 months recall; • Included the patients who missed at least 1 maintenance visit; • Maximum interval 18 months.	Prospective cohort study. Evaluated tooth loss over a 5-year period based on regular vs. irregular compliance with recall visits.	Outcomes: 1. Mean annual tooth loss/patient RC = 0.12 teeth IC = 0.36 teeth ($P < 0.01$) Subjects who lost teeth: 25% (n = 24) in RC; 34.5% (n = 40) in IC. 1. IC group had higher tooth loss in last 3 years of study. 2. OR of tooth loss (logistic regression): • IC = 3.13 • Male = 1.86 • Smoking = 4.22 • DM = 2.73 • 4-6 mm PPDs in up to 10% of sites = 3.47 3. β estimate of tooth loss (linear regression.): • IC = 0.284 • Male = 0.116 • Smoking $\frac{1}{4}$ 0.002 • 4-6 mm PPD in up to 10% of sites $\frac{1}{4}$ 0.197 4. Smokers lost more teeth than non-smokers, regardless of compliance level. Covariates: 1. Compliance w/MT 2. Gender 3. Age 4. Cohabitation status 5. Smoking 6. Diagnosis of diabetes 7. BMI 8. Bleeding on probing

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Miyamoto T. et al., J Periodontol, 2006 ²⁴	Good	N = 505 PM patients in a single private practice in Japan. Followed for 15 yrs; in PM for 10 yrs.	Maintenance prescribed every 3 or 6 months	MODEL 1 Complete Compliers (CC1): Attended at least 70% of expected visits; <i>n</i> = 180 (35.6%) Erratic Compliers (EC1): Missed >30% of expected visits; <i>n</i> = 325 (64.4%) MODEL 2 Complete Compliers (CC2): Attended MOST of expected visits; <i>n</i> = 164 (32.5%) Erratic Compliers (EC2): Absent for a minimum of 2 years; <i>n</i> = 341 (67.5%) Total non-compliers were excluded.	Retrospective cohort study. Evaluated compliance and other variables related to outcomes of tooth loss and improvement in periodontal status.	9. Probing depth (measured 2 ways) 10. Clinical attachment level Outcomes: Compliance Model 1: CC1 more likely to lose teeth versus EC1 (55.6% vs. 40.3%, <i>p</i> < 0.001). Multiple logistic regressions analysis showed CC1 were 42% more likely to experience tooth loss compared to EC1. Compliance Model 2: No significant differences were noted in tooth loss or other periodontal outcomes between CC2 and EC2 with a 2-year interval of absenteeism. Covariates: 1. Compliance (measured 2 ways) 2. Age 3. Gender 4. Smoking 5. Length of MT
Tsami A et al., JADA, 2009 ²⁵	Good	N = 280 Single private practice in Athens, Greece. Participants: 1. Had generalized severe chronic periodontitis. 2. Had at least 20 teeth. 3. Had no systemic diseases affecting periodontitis. 4. Took no systemic medications. 5. Were in PM for 8 yrs.	Every 3 or 4 months	Complete Compliers (CC): Kept 75% of scheduled MT appointments <i>n</i> = 148 (53%) Erratic Compliers (EC): Kept 40-74% of maintenance appointments <i>n</i> = 132 (47%) No subjects kept <40% of appointments. Total non-compliers were excluded.	Retrospective cohort study. Assessed rate of tooth loss during PM.	Outcomes: 1. Mean annual tooth loss overall 0.3 teeth/patient 2. EC 1.5 times more likely to lose teeth than CC. Covariates: 1. MT compliance 2. Age 3. Sex 4. Smoking 5. Initial tooth prognosis 6. Tooth type 7. Restoration quality
Checchi L. et al. J CLin Periodontol, 2002 ²⁶	Fair	N = 92 Private practice in Italy. Participants: 1. Completed surgical periodontal therapy. 2. In PM from 3-12 years (mean = 6.7 years)	3-4 months	Compliant Every 3-4 months for the duration of PM; <i>n</i> = 59 (64%) Non-compliant Less than every Interval. Interval longer than 3-4 months for the duration of PM; <i>n</i> = 33 (36%) Total non-compliers were excluded.	Retrospective cohort study through chart review. Evaluated tooth loss in relation to various post-PT variables.	Outcomes 1. Tooth loss = 0.07/patient/year 2. NC were 5.6 times more likely to lose teeth (CI 1.90-16.3) 3.72% of all participants lost no teeth. Covariates 1. Age 2. Plaque index 3. Pre-treatment perio prognosis 4. Periodontal prognosis of remaining teeth 5. Tooth morphology
Wilson TG et al., J Periodontol, 1987 ²⁷	Fair	N = 162 Single private practice in U.S. Followed for 5 years	Initially 3 months for all patients; later customized according to	Complete Compliers (CC): Attended 100% of recommended visits; <i>n</i> = 58 (36%)	Retrospective cohort study	Outcomes: 1. CC lost fewer teeth than EC. 2. Among EC, those seen more frequently for PM tended to lose fewer teeth. (Paper

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Seirafi A et al.; J Int'l Academy Periodontol, 2014 ²⁸	Poor	N = 72 Single private practice in Iran. Moderate/moderate-severe chronic periodontitis. Patients had 14 teeth. PM follow-up = 10 yrs. Mean age: 51.3 yrs	3-6 months	Erratic Compliers (EC): Attended <100% of recommended visits; n = 104 (64%) Non-compliers were excluded. Regular Compliers (RC): Attended 70% of expected visits, e.g. attended 14 appointments during 10-year period. Erratic Compliers (EC): Failed to attend >30% of expected visits, e.g. attended 6 appointments during 10 year period. Patients who attended 7-13 appointments were excluded.	Retrospective cohort study	provides only descriptive analyses; no statistical significance was evaluated.) Covariates: PM compliance Outcomes: Compare tooth loss between RC and EC after 10 years. 1. Teeth lost per person over 10 years of PM: RC: 1.50 ± 1.71 (NS) EC: 1.43 ± 2.34 (NS) <i>As published; calculated by subtracting population's mean# teeth on initial and final exams.</i> 2. Teeth lost per patient over 10 years of PM: RC: 1.14 EC: 1.57 <i>Hand calculated using published report of actual# teeth lost in each group.</i> Covariates: No modeling was performed.
Wood WR et al.; J Periodontol, 1989 ²⁹	Poor	N = 63 Patients with generalized moderate chronic periodontal disease treated at University of North Carolina Attended PM average of 13.6 years. Mean age: 45 years Male = 35%	Recall interval is not clearly defined. Reported that only 30% of all the patients in the study returned for PM with an interval of 6 months or less.	Groups were defined based on number of teeth lost. Well Maintained (WM): Lost 0-3 teeth/patient; n = 54 (85.7%) Downhill (DH): Lost 4-9 teeth/patient; n = 7 (11.1%) Extreme Downhill (ED): Lost 10-23 teeth/patient; n = 2 (3.2%) Non-compliers were not assessed in this study.	Retrospective cohort study	Outcomes: • Tooth loss over the average of 13.6 years of Periodontal Maintenance • Tooth loss (periodontal destruction): 1.40 teeth/patient • WM Group lost 0.61 tooth/patient over the average of 13.6 years of the study. Recall distributed by tooth loss: • 35% (n = 19) of WM group attended PM at intervals 6 months. • 100% (n = 9) of DH and ED groups attended PM at intervals 6 months. Covariates: 1. Age 2. Sex 3. Race 4. Initial periodontal status 5. Time in PM 6. # of teeth initially present 7. Tooth type 8. Compliance categories

AC – all compliers; APT – active periodontal therapy; BMI – body mass index; CC – complete compliers; DH – downhill group; DM – diabetes mellitus; EC – erratic compliers; ED – extreme downhill group; IC – irregular compliers; MT – maintenance therapy; NC – non-compliers; NS – not significant; OR – odds ratio; PD – periodontal disease; PPD – periodontal pocket depth; PM – periodontal maintenance; PT – periodontal treatment; RC – regular compliers; WM – well-maintained group.

^aRatings were determined by verbal consensus of the authors using the CASP review form during Phase II review.²²