Japanese Dental Science Review 60 (2024) 148–153

Contents lists available at ScienceDirect

Japanese Dental Science Review

journal homepage: www.elsevier.com/locate/jdsr

Review article

Dental and oral management in the perioperative period of surgery: A scoping review

Hironori Sakai [a,*], Hiroshi Kurita [a], Eiji Kondo [a], Hirokazu Tanaka [a], Tetsu Shimane [a], Masao Hashidume [a], Shin-Ichi Yamada [b]

[a] *Department of Oral and Maxillofacial Surgery, Shinshu University School of Medicine, 3-1-1 Asahi, Matsumoto-shi, Nagano-ken 390-0872, Japan*
[b] *Department of Oral and Maxillofacial Surgery, Graduate School of Medicine and Pharmaceutical Sciences, University of Toyama, 3190 Gofuku, Toyama-shi, Toyama-ken 930-8555, Japan*

ARTICLE INFO

Keywords:
Dental management
Oral management
Surgical site infections
Postoperative pneumonia

ABSTRACT

Dental and oral management (DOM) is a long-established treatment modality. This scoping review aimed to narratively review previous studies, examine the effects of perioperative DOM, and identify the available evidence. A literature search was conducted using the PubMed electronic database for studies published between January 1, 2000, and March 8, 2022. The search yielded 43 studies, most of which were published in the last 10 years. The results of this study confirmed that improved perioperative oral hygiene is effective in preventing postoperative pneumonia. Our results also suggested that preoperative DOM is effective in preventing postoperative surgical site infections. Perioperative DOM is effective in reducing the incidence of postoperative pneumonia, SSI, and postsurgical complications. Further studies are needed to elucidate the various mechanism of DOM and to examine efficient intervention methods and timing.

1. Introduction

Dental and oral management (DOM) has long been a part of anti-cancer therapy, hematopoietic stem cell transplantation, and cardiac surgery. Infectious dental lesions and oral bacteria are factors correlated with complications and adverse events during treatment, which also affect treatment and disease outcome. In anti-cancer drug therapy and head and neck radiotherapy, oral complications such as oral mucositis occur frequently and severely, and DOM is essential for its prevention and management [1]. In recent years, it has been reported that proactive oral management is effective in preventing ventilator-associated pneumonia (VAP) [1], a type of pneumonia that develops in persons who have received mechanical ventilation for at least 48 h [1]. To reduce the potential risks of VAP, oral management is considered a viable preventative strategy. In addition, it has been expected that DOM during the perioperative period can prevent postoperative complications such as pneumonia [2–20] and surgical site infections [21–26] (SSI), leading to shortened hospital stay, reduced medical costs, and improved quality of life of patients [2–26]. Postoperative pneumonia (POP) is defined as patients with three or more of the following indicators [27,28]: (i) patients with a fever (temperature $> 38\,^{\circ}$C) 72 h after surgery or once more within 72 h; (ii) increased white blood cell count ($> 12 \times 10^9$/L–15×10^9/L), or second increase ($> 10 \times 10^9$/L) after it returned to normal; (iii) chest imaging showed consolidation or increasing patchy shadows of lung tissues; and (iv) patients coughed up purulent sputum, or were confirmed sputum culture-positive. Patients who meet indicator (iv) and one other criterion are also considered to have POP [29]. SSIs are generally defined using the CDC guidelines for SSI prevention [21] and are divided into incisional (superficial and deep) and organ/space SSIs. The latter also include anastomotic leaks [22]. .

In 2012, Japan became the first country in the world to introduce perioperative DOM into its medical insurance system, and many medical institutions now provide DOM for the patients who undergo surgery, chemotherapy, and radiotherapy. Perioperative DOM is a program in which dentists and dental hygienists provide comprehensive oral care during the perioperative period. to prevent or reduce perioperative complications, maintain or improve nutritional status, improve treatment outcomes and quality of life, shorten hospital stays, and optimize medical costs. Perioperative DOM is defined as follows:

* Correspondence to: Shinshu University School of Medicine, 3-1-1 Asahi, Matsumoto-shi, Nagano-ken 390-0872, Japan.
E-mail address: hironori_sakai@shinshu-u.ac.jp (H. Sakai).

https://doi.org/10.1016/j.jdsr.2024.03.002
Received 3 November 2023; Received in revised form 27 February 2024; Accepted 25 March 2024

1. Improvement of oral hygiene, including oral cleansing and moisturization, to prevent pneumonia and wound infection, and to improve or reduce mucositis and stomatitis.
2. Control of odontogenic oral diseases, such as dental caries treatment and periodontal disease treatment, with the aim of preventing dental and blood infections, and creating mouthpieces to immobilize upset teeth.
3. Maintenance and improvement of oral function, such as prosthetic treatment, oral function training and salivary gland function maintenance, with the aim of maintaining and improving oral intake, saliva volume and dysphagia.

Performing these steps can lead to the prevention and reduction of perioperative complications and adverse events, maintenance and improvement of nutritional status, improvement of treatment outcomes of the underlying disease, maintenance and improvement of quality of life, administration of high-quality healthcare (total quality), control of healthcare costs, and prevention of dental and oral disorders (Fig. 1). Although perioperative DOM has been widely adopted in Japanese healthcare, scientific evidence for the efficacy of perioperative DOM remains relatively scarce. In this study, we narratively reviewed previous studies and examined the effect of DOM in the perioperative period of surgery to identify the available evidence.

2. Methods

A literature search was conducted using the electronic databases of PubMed for studies published between January 1st, 2000, and March 8th, 2022. This was conducted by one author (HK). The search formula used was as follows: (("perioperative care"[MeSH Terms] AND "oral health"[MeSH Terms]) OR ("perioperative care"[MeSH Terms] AND "dental care"[MeSH Terms]) OR ("perioperative care"[MeSH Terms] AND "dental health surveys"[MeSH Terms]) OR ("perioperative care"[-MeSH Terms] AND "oral care"[Title]) OR ("perioperative care"[MeSH Terms] AND "oral management"[Title])) AND (2000/1/1:2022/3/8 [pdat]) The inclusion criteria were English-language systematic reviews (SR) and interventional/case-control/cross-sectional studies that were published in peer-reviewed journals. The exclusion criteria were narrative reviews, opinion papers, case reports, abstracts, and animal model and/or in-vitro studies. Two members (HS and HK) screened the titles and abstracts and then full text of the selected papers and selected according to the inclusion and exclusion criteria. Any disagreements were resolved by consensus and consultation with the third reviewer (EK) when required. Through examination of the extracted studies, the papers that were cited were also reviewed and added to the list of papers if necessary (hand search).

Risk of bias and indirectness of each included studies were assessed independently by two authors (HS and HK) using a modified Minds Clinical Practice Guideline Development Manual [30] 2020 ver. 3.0 and assigned a value of "high," "moderate," or "low." Discrepancies in the assessment were resolved through discussion until a consensus was reached. The results of the Cochrane review for risk-of-bias [31], certainty of the evidence (GRADE) [32], and Newcastle-Ottawa Scale assessment [33] written in the adopted SR article were quoted verbatim.

3. Results

The electronic searches identified 168 titles and abstracts. After examination of the abstracts and full-text studies by the reviewers, 24 studies satisfied the inclusion criteria. Additionally, by checking "similar studies" in PubMed, we added 20 studies. Finally, 43 studies (general surgery, 8; lung surgery, 2; esophageal surgery, 9; open chest surgery, 2; gastrointestinal surgery, 8; orthopedic surgery, 5; heart surgery, 9) were available for review (Fig. 2). A detailed presentation of the included studies on perioperative dental and oral management are presented according to fields of discipline (Supplementary material).

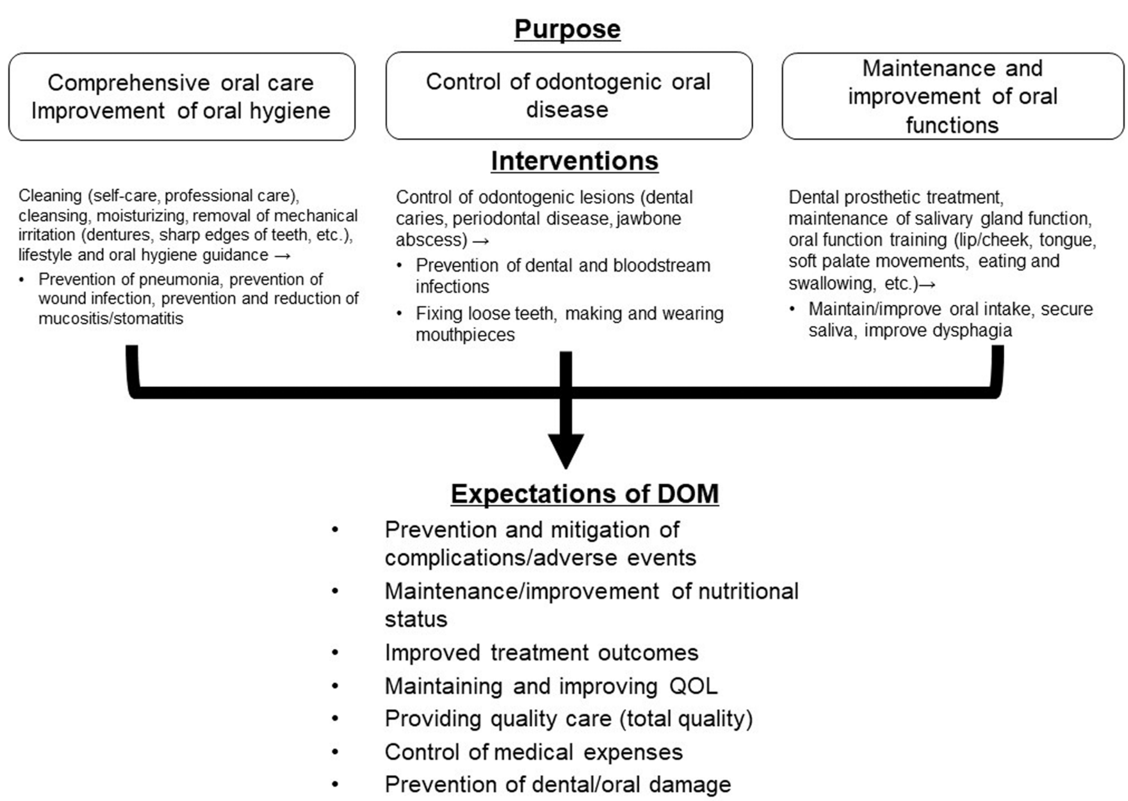

Fig. 1. Purpose of perioperative oral management. The flowchart summarizes the aims of perioperative oral management.

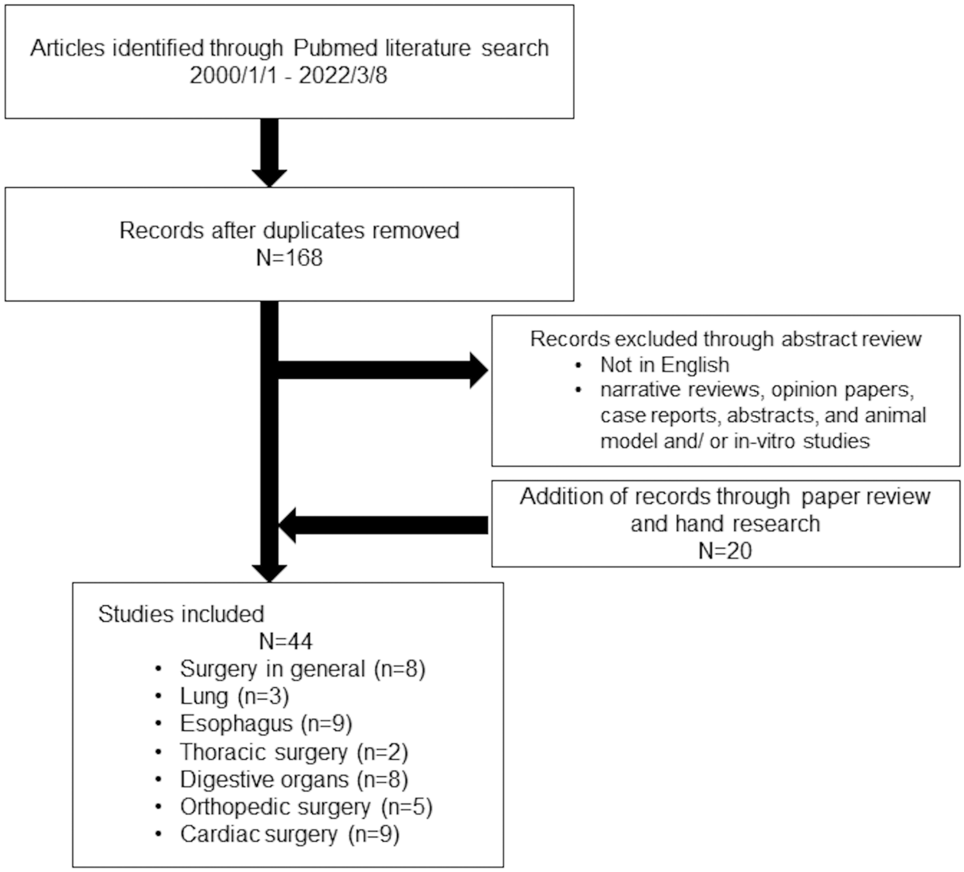

Fig. 2. Workflow of paper search. The flowchart summarizes the methodology of the paper search.

3.1. *General surgery*

Eight studies were obtained that examined a combination of various types of surgery (two SRs and six observational studies) [2–6,34–36]. An SR by Liang et al. [2] examined the effect of nurse-led perioperative chlorhexidine oral care and dental professional-led perioperative oral care on postoperative pneumonia and postoperative mortality in surgical patients, excluding cardiac patients. The authors reported a significant reduction in both events (one quality of evidence was rated as low and three as high). An SR by Zhao et al. [34] reported that chlorhexidine (mouthwash or gel) and tooth brushing significantly reduced the incidence of ventilator-associated pneumonia in a study of critically ill patients (certainty of the evidence [GRADE] was one moderate and one low). They also reported significantly shorter ICU stays in the tooth brushing group (certainty of the evidence [GRADE]: very low).

Six observational studies compared the patients with and without perioperative oral management, four of which analyzed big data from national health insurance databases. Five studies examined the effect on postoperative pneumonia, four [3,4,6,36] reported significant preventive effect, and one [17] reported no significant effect (all with low risk of bias). Additionally, Ishimaru et al. [6] reported that preoperative oral care by a dentist was significantly associated with a decrease in all-cause mortality within 30 days of surgery (low risk of bias). Yamada et al. [35] examined pre- and postoperative changes in serum albumin levels and found that perioperative and other oral function management had significant positive effect on maintaining serum albumin levels (low risk of bias).

3.2. *Lung surgery*

There were three observational studies of lung resection [7,8,29]. All studies examined the effect of perioperative oral management on the prevention of postoperative pneumonia, two [8,29] reporting a statistically significant, and the other [7] reporting a near-significant preventive effect (risk of bias was low in 2 and moderate in one). Additionally, Ishikawa et al. [7] examined the number of postoperative hospital days and reported that the group that received perioperative oral management had a significantly shorter hospital stay than the group that did not (risk of bias was low).

3.3. *Esophageal Surgery*

There were nine observational studies [9–17]. Seven studies [10, 12–17] compared the incidence of postoperative pneumonia between the groups that received perioperative oral management and those did not, and all reported a significantly lower incidence of postoperative pneumonia in the group that received perioperative oral management (risk of bias: 4 were low and 3 were moderate). Two other studies [9,12] examined the association between oral hygiene status of patients who underwent perioperative oral functional management and the incidence of postoperative pneumonia and reported that the degree of improvement in oral hygiene was significantly associated with the incidence of postoperative pneumonia (those with improved oral hygiene had less incidence of pneumonia; risk of bias was high for both).

3.4. *Open chest surgery*

Two studies [18,19] included patients who underwent open chest surgery (one SR and one observational study). The SR [18] examined the effect of professional oral cleaning and gargling on prevention of nosocomial infections, respiratory infections, and deep SSI, and reported statistically significant positive effect in preventing all three complications (certainty of the evidence [GRADE] was moderate in all three outcomes). An observational study [19] compared the incidence of postoperative pneumonia in patients undergoing open chest surgery (lung + esophagus) with and without preoperative periodontal therapy and reported significantly fewer cases of postoperative pneumonia in the group treated with periodontal therapy than in the group without (risk of bias was moderate).

3.5. Gastrointestinal surgery

There was one randomized controlled trial (RCT) and seven observational studies [20–25,37–39]. The RCT [20] reported significantly less postoperative increase in lung murmurs, but no significant difference in increased body temperature (risk of bias was high). In the observational studies, five studies [22–25,37] examined the frequency of postoperative SSI between patients with and without perioperative oral management, and all reported a significantly lower frequency of SSI in the patients with perioperative oral management than without (risk of bias was low in all studies). Nishikawa et al. [39] examined the association between SSI and periodontal disease status in patients who underwent perioperative oral management and found that severity of periodontal disease was a significant risk factor for SSI. Otagiri et al. [38] compared the prognostic nutritional index (PNI) of patients with and without perioperative oral management and found that postoperative PNI was significantly higher in the patients with perioperative oral management than in those without.

3.6. Orthopedic surgery

There were five observational studies including four reports on joint replacement [40–43] and one [26] on spinal surgery. Two studies [40,42] compared the frequency of postoperative infection in patients undergoing total joint arthroplasty between patients with and without preoperative dental evaluation and reported no significant difference between the two groups (risk of bias, moderate and high). Sonn et al. [40] also compared the frequency of postoperative infections between patients who had preoperative dental extractions and those who did not and reported no significant difference in infectious complications between them (risk of bias, moderate). However, Barrington et al. [43] reported no SSI in a cohort of patients who underwent dental clearance before joint replacement, although the study did not have a control group. Tai et al. [41] compared a frequency of dental scaling before total knee joint arthroplasty between patients with and without surgical joint infection and reported that frequent dental scaling is associated with a reduced risk of periprosthetic infection (risk of bias, moderate). Mirzashahi et al. [26] examined the dental status of spinal surgery patients and reported that the presence of dental and periodontal disease was significantly associated with postoperative SSI.

3.7. Cardiac Surgery

There were three SRs, one RCT, and five observational studies [44–52]. An SR by Wei et al. [44] and Bardia et al. [45] examined the incidence of postoperative pneumonia and nosocomial infections between patients who underwent oral rinsing with chlorhexidine and those who underwent rinsing with other drugs or no rinsing. Both studies reported significantly lower incidences in the chlorhexidine group (both risk of bias, low). An SR by Lockhart et al. [46] examined the effects of professional dental treatment as oral health care on all-cause mortality, development of infective endocarditis, postoperative infection, and postoperative hospital days. The authors reported that the desired effects (control, reduction) were not obtained, although the certainty of the evidence (GRADE) was considered very low.

The RCT [47] examined the number of postoperative atrial fibrillation days between the intensive oral hygiene and routine oral hygiene groups and reported significantly fewer days in the intensive oral hygiene group (risk of bias; high). In the observational studies, Suzuki et al. [51] reported significantly fewer days of postoperative fever-up in heart valve surgery patients who received periodontal therapy before surgery than in those who did not (risk of bias; moderate). Rao et al. [50] compared early postoperative mortality in heart valve surgery patients treated with a comprehensive versus a focused dental approach and found no significant difference between them (risk of bias; moderate). Bergan et al. [52] compared the incidence of postoperative pneumonia between groups with and without improvement in oral hygiene and reported significantly less postoperative pneumonia in the group with an improved oral hygiene (risk of bias; moderate). In other studies, it was reported that lower postoperative oral bacteria count resulted in fewer postoperative adverse events [49], and dental surgical procedures prior to cardiac surgery were associated with less frequent and less severe dental and medical adverse events [48].

4. Discussion

Postoperative surgical complications are an important issue in highly invasive surgical procedures. Postoperative pneumonia including ventilator-associated pneumonia are known to be the most frequent complications. Since tracheal intubation is performed via the oral cavity and pharyngeal space, a high percentage of these cases are thought to be caused by oral/oropharyngeal bacteria [53,54]. SSI and failure to heal are also important postoperative complications, which may be partly due to nutritional disorders caused by poor oral intake, bloodstream infection [55–58] from chronic dental/oral infections, contamination of wound by saliva, and suppression of immune surveillance mechanisms that are indirectly caused by chronic dental infections [59]. Dental and oral bacteria are also suspected to be involved as a source of bacteria for sepsis and bloodstream infections in the condition of reduced physical and immune condition at the time of surgery. Therefore, improving the oral environment, controlling dental infections, and enhancing oral function to reduce aspiration and improve masticatory function during the perioperative period are thought to be effective in preventing surgical complications and improving patient prognosis and quality of life, as well as in saving healthcare costs and resources. In the present study, we have reviewed the research papers that support these findings.

We searched articles published between January 1, 2000 and March 8, 2022. The search yielded 43 studies, most of which were published in the last 10 years. Twenty-two studies [2–8,10,11,13–20,29,34,36,44,45] compared the frequency of postoperative pneumonia in patients who received DOM, and all but one study [5] reported that DOM was effective in preventing postoperative pneumonia. Three other studies [9,12,52] examined the relationship between oral hygiene and the incidence of postoperative pneumonia, reporting that better oral hygiene was associated with a lower incidence of postoperative pneumonia. It is known that oral and oropharyngeal bacteria are often the initiators of postoperative pneumonia. The present results confirm that improving oral hygiene in the perioperative period is effective in preventing postoperative pneumonia. No differences were observed by surgical site. In clinical practice, the incidence of postoperative pneumonia was generally lower after the introduction of perioperative oral functional management. Although few reports have described the details of postoperative pneumonia management, dental professional intervention [2,18,19,52], gargling with chlorhexidine or popioniodine, [2,20,34,44,45] oral care including the tongue [16], and increased frequency of tooth brushing [17] have been reported and were all considered effective.

Wound infection and failure to heal are notable problems in surgery. In oral, head, and neck surgery where the oral cavity is the surgical site, oral hygiene and the presence of infected sites can cause SSI; therefore, aggressive preoperative measures are taken. Regarding other surgical sites, fifteen studies examined the effectiveness of DOM in preventing postoperative SSI and postoperative complications. Eleven of the studies [5,18,22–25,37,40–42,47] compared the incidence of SSI between patients with and without preoperative DOM. Eight studies reported that DOM had a significant reduction effect, while three studies [5,42,46] reported no significant effect. The surgeries in which the infection-reducing effect was seen were gastrointestinal, joint replacement, and open chest surgery. The one paper that reported no effect was for heart valve surgery [46], while a paper examining open chest surgery including heart valve surgery [18] reported a significant positive effect. The other paper, which evaluated joint replacement surgery [42], reported no significant effect; however, the risk of bias of the study was determined to be high. Other papers [26,37,43,49] examined the association between SSI and dental/oral conditions and reported a significant correlation between either higher oral bacterial loads or higher prevalence and severity of dental disease and occurrence of SSI. These results indicate that preoperative DOM is effective in preventing postoperative SSI. In clinical practice, the incidence of SSIs was generally reduced after the introduction of perioperative oral functional management. Although studies that provide a detailed description of SSI management remain relatively scarce in the literature, dental professional interventions [18,24,26,43,46] and intensive oral care [38] have been reported and were all considered effective. Sonn et al. [40] reported a higher rate of postoperative infection with preoperative tooth extractions. The causes and timing of tooth extraction warrant further investigation.

As other benefits of perioperative DOM, length of hospital stay [7,15,22,46] and mortality [2,5,15,34,46,50] were studied. Of the four papers that examined the length of hospital stay, two [7,22] reported a significant reduction in length of hospital stay with perioperative DOM, while the other two reported no effect. One paper [2] reported significantly fewer deaths from complications of surgery in patients who received perioperative DOM.

As mentioned above, perioperative DOM was shown to be effective in preventing pneumonia and SSI associated with surgery, but the mechanism of this effect remains unclear. The mechanism by which oral and pharyngeal bacteria drip down into the respiratory tract during the perioperative period is plausible, and there is no dispute that oral cleansing is effective in preventing postoperative pneumonia including VAP [1]. Another mechanism is that maintenance and improvement of oral function may also maintain and improve nutritional status, which may be beneficial to healing and the immunological ability of the patient. Previously, we reviewed postoperative nutritional and immunological status of surgical patients and found that postoperative nutritional status was significantly better when DOM was performed during the perioperative period [35,38]. In addition, it has been pointed out that chronic foci of infection in dental disease and damage to the oral mucosa may be a possible gateway for bacterial invasion into the bloodstream [56,57]. We reviewed the results of blood culture bacteriology in hospitalized patients with suspected sepsis and reported a significant decrease in the frequency of detection of oral commensal bacteria after the introduction of perioperative DOM compared to before [58]. In another study, we reported that cancer patients with periodontal disease have compromised and impaired immune surveillance mechanisms [59]. Further studies are needed to determine the impact of oral micro foci on bloodstream infections and immune mechanisms.

Most of the studies did not mention the harms of perioperative DOM. Two studies [2,48] reported that preoperative DOM did not cause any dental or systemic adverse events. However, it has been pointed out that bacteremia associated with dental procedures may be a cause of implant infection [40,60]. On the other hand, there were variations in the content of dental and oral health management among studies and facilities [61]. We believe that a more efficient and effective perioperative DOM system could be established in conjunction with the surgical schedule by examining the details of dental and oral management.

In conclusion, the results of this study indicate that DOM during the perioperative period is effective in reducing the incidence of postoperative pneumonia, postoperative SSI, and complications. Further studies are needed to elucidate the various mechanism of DOM and to examine efficient intervention methods and timing.

Role of the funding source

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

All authors contributed sufficiently to the project to be included as authors, and all those who are qualified to be authors are listed in the author by-line. In addition, all authors have approved the final version of the manuscript being submitted, and we have analyzed the manuscript to verify that the review has been written according to the COPE guidelines. This research did not receive any specific funding from any agencies in the public, commercial, or not-for-profit areas. Furthermore, the authors have no conflicts of interests or disclosures to report.

Acknowledgements

None.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jdsr.2024.03.002.

References

[1] Shi Z, Xie H, Wang P, Zhang Q, Wu Y, Chen E, et al. Oral hygiene care for critically ill patients to prevent ventilator-associated pneumonia. Cochrane Database Syst Rev 2013;8:CD008367.

[2] Liang S, Zhang X, Hu Y, Yang J, Li K. Association between perioperative chlorhexidine oral care and postoperative pneumonia in non-cardiac surgical patients: a systematic review and meta-analysis. Surgery 2021;170:1418–31.

[3] Sekiya H, Kurasawa Y, Kaneko K, Takahashi KI, Maruoka Y, Michiwaki Y, et al. Preventive effects of sustainable and developmental perioperative oral management using the "oral triage" system on postoperative pneumonia after cancer surgery. Int J Environ Res Public Health 2021;18:6296.

[4] Kurasawa Y, Maruoka Y, Sekiya H, Negishi A, Mukohyama H, Shigematsu S, et al. Pneumonia prevention effects of perioperative oral management in approximately 25,000 patients following cancer surgery. Clin Exp Dent Res 2020;6:165–73.

[5] Ishimaru M, Ono S, Matsui H, Yasunaga H. Association between perioperative oral care and postoperative pneumonia after cancer resection: conventional versus high-dimensional propensity score matching analysis. Clin Oral Investig 2019;23:3581–8.

[6] Ishimaru M, Matsui H, Ono S, Hagiwara Y, Morita K, Yasunaga H. Preoperative oral care and effect on postoperative complications after major cancer surgery. Br J Surg 2018;105:1688–96.

[7] Ishikawa S, Yamamori I, Takamori S, Kitabatake K, Edamatsu K, Sugano A, et al. Evaluation of effects of perioperative oral care intervention on hospitalization stay and postoperative infection in patients undergoing lung cancer intervention. Support Care Cancer 2021;29:135–43.

[8] Iwata E, Hasegawa T, Yamada SI, Kawashita Y, Yoshimatsu M, Mizutani T, et al. Effects of perioperative oral care on prevention of postoperative pneumonia after lung resection: multicenter retrospective study with propensity score matching analysis. Surgery 2019;165:1003–7.

[9] Kuriyama K, Sohda M, Watanabe T, Saito H, Yoshida T, Hara K, et al. Resistance to preoperative oral care is associated with postoperative pneumonia after oesophageal cancer surgery. Anticancer Res 2021;41:1507–14.

[10] Soutome S, Hasegawa T, Yamguchi T, Aoki K, Kanamura N, Mukai T, et al. Prevention of postoperative pneumonia by perioperative oral care in patients with esophageal cancer undergoing surgery: a multicenter retrospective study of 775 patients. Support Care Cancer 2020;28:4155–62.

[11] Shin JH, Kunisawa S, Fushimi K, Imanaka Y. Effects of preoperative oral management by dentists on postoperative outcomes following esophagectomy: Multilevel propensity score matching and weighting analyses using the Japanese inpatient database. Medicine 2019;98:e15376 [Erratum in: Medicine (Baltimore). 2019;98:e17243].

[12] Yamada Y, Yurikusa T, Furukawa K, Tsubosa Y, Niihara M, Mori K, et al. The effect of improving oral hygiene through professional oral care to reduce the incidence of pneumonia post-esophagectomy in esophageal cancer. Keio J Med 2019;68:17–25.

[13] Soutome S, Yanamoto S, Funahara M, Hasegawa T, Komori T, Yamada SI, et al. Effect of perioperative oral care on prevention of postoperative pneumonia associated with esophageal cancer surgery: a multicenter case-control study with propensity score matching analysis. Medicine 2017;96:e7436.

[14] Sato Y, Motoyama S, Takano H, Nakata A, Liu J, Harimaya D, et al. Esophageal cancer patients have a high incidence of severe periodontitis and preoperative dental care reduces the likelihood of severe pneumonia after esophagectomy. Dig Surg 2016;33:495–502.
[15] Soutome S, Yanamoto S, Funahara M, Hasegawa T, Komori T, Oho T, et al. Preventive effect on post-operative pneumonia of oral health care among patients who undergo esophageal resection: a multi-center retrospective study. Surg Infect 2016;17:479–84.
[16] Hiramatsu T, Sugiyama M, Kuwabara S, Tachimori Y, Nishioka M. Effectiveness of an outpatient preoperative care bundle in preventing postoperative pneumonia among esophageal cancer patients. Am J Infect Control 2014;42:385–8.
[17] Akutsu Y, Matsubara H, Shuto K, Shiratori T, Uesato M, Miyazawa Y, et al. Pre-operative dental brushing can reduce the risk of postoperative pneumonia in esophageal cancer patients. Surgery 2010;147:497–502.
[18] Pedersen PU, Larsen P, Håkonsen SJ. The effectiveness of systematic perioperative oral hygiene in reduction of postoperative respiratory tract infections after elective thoracic surgery in adults: a systematic review. JBI Database Syst Rev Implement Rep 2016;14:140–73.
[19] Jia C, Luan Y, Li X, Zhang X, Li C. Effects of periodontitis on postoperative pneumonia in patients with lung and esophageal cancer. Thorac Cancer 2021;12:768–74.
[20] Sato M, Yoshihara A, Miyazaki H. Preliminary study on the effect of oral care on recovery from surgery in elderly patients. J Oral Rehabil 2006;33:820–6 [Erratum in: *J Oral Rehabil* 2007;34:77].
[21] Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Centers for Disease Control and Prevention (CDC) hospital infection control practices advisory committee. Am J Infect Control, Vol. 27; 1999, p. 97–132. [quiz 3–4; discussion 96].
[22] Nobuhara H, Matsugu Y, Soutome S, Hayashida S, Hasegawa T, Akashi M, et al. Perioperative oral care can prevent surgical site infection after colorectal cancer surgery: a multicenter, retrospective study of 1,926 cases analyzed by propensity score matching. Surgery 2022;172:530–6.
[23] Nobuhara H, Matsugu Y, Tanaka J, Akita T, Ito K. The preventive effects of perioperative oral care on surgical site infections after pancreatic cancer surgery: a retrospective study. Support Care Cancer 2022;30:3337–44.
[24] Hasegawa T, Takeda D, Tanaka M, Amano R, Saito I, Kakei Y, et al. Effects of preoperative dental examination and oral hygiene instruction on surgical site infection after hepatectomy: a retrospective study. Support Care Cancer 2021;29:653–9.
[25] Nobuhara H, Yanamoto S, Funahara M, Matsugu Y, Hayashida S, Soutome S, et al. Effect of perioperative oral management on the prevention of surgical site infection after colorectal cancer surgery: a multicenter retrospective analysis of 698 patients via analysis of covariance using propensity score. Medicine 2018;97:e12545.
[26] Mirzashahi B, Tonkaboni A, Chehrassan M, Doosti R, Kharazifard MJ. The role of poor oral health in surgical site infection following elective spinal surgery. Musculoskelet Surg 2019;103:167–71.
[27] Kaneda H, Nakano T, Taniguchi Y, Saito T, Konobu T, Saito Y. Impact of previous gastrectomy on postoperative pneumonia after pulmonary resection in lung cancer patients. Interact Cardiovasc Thorac Surg 2012;14:750–3.
[28] Savardekar A, Gyurmey T, Agarwal R, et al. Incidence, risk factors, and outcome of postoperative pneumonia after microsurgical clipping of ruptured intracranial aneurysms. Surg Neurol Int 2013;4:24.
[29] Jia C, Sun M, Wang W, Li C, Li X, Zhang X, et al. Effect of oral plaque control on postoperative pneumonia following lung cancer surgery. Thorac Cancer 2020;11:1655–60.
[30] Minds Clinical Practice Guideline Development Manual 2020 ver. 3.0. ⟨https://minds.jcqhc.or.jp/docs/various/manual_2020/ver3_0/pdf/all_manual_2020ver3_0.pdf⟩. [Accessed 24 August 2022].
[31] Lundh A, Gøtzsche PC. Recommendations by Cochrane Review Groups for assessment of the risk of bias in studies. BMC Med Res Methodol 2008;8:22.
[32] Kirmayr M, Quilodrán C, Valente B, Loezar C, Garegnani L, Franco JVA. The GRADE approach, Part 1: how to assess the certainty of the evidence. Medwave 2021;21:e8109.
[33] Stang A. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. Eur J Epidemiol 2010;25:603–5.
[34] Zhao T, Wu X, Zhang Q, Li C, Worthington HV, Hua F. Oral hygiene care for critically ill patients to prevent ventilator-associated pneumonia. Cochrane Database Syst Rev 2020;(12):CD008367.
[35] Yamada SI, Koike K, Isomura ET, Chikazu D, Yamagata K, Iikubo M, et al. The effects of perioperative oral management on perioperative serum albumin levels in patients treated surgically under general anesthesia: a multicenter retrospective analysis in Japan. Medicine 2021;100:e25119.
[36] Sekiya H, Kurasawa Y, Maruoka Y, Mukohyama H, Negishi A, Shigematsu S, et al. Cost-effectiveness analysis of perioperative oral management after cancer surgery and an examination of the reduction in medical costs thereafter: a multicenter study. Int J Environ Res Public Health 2021;18:7453.
[37] Nishikawa M, Honda M, Kimura R, Kobayashi A, Yamaguchi Y, Hori S, et al. The effects of intensive oral care before surgery for gastric cancer patients. Oral Dis 2021;27:1847–53.
[38] Otagiri H, Yamadav S, Hashidume M, Sakurai A, Morioka M, Kondo E, et al. A clinical investigation of the association between perioperative oral management and prognostic nutritional index in patients with digestive and urinary cancers. Curr Oncol 2020;27:257–62.
[39] Nishikawa M, Honda M, Kimura R, Kobayashi A, Yamaguchi Y, Kobayashi H, et al. Clinical impact of periodontal disease on postoperative complications in gastrointestinal cancer patients. Int J Clin Oncol 2019;24:1558–64.
[40] Sonn KA, Larsen CG, Adams W, Brown NM, McAsey CJ. Effect of preoperative dental extraction on postoperative complications after total joint arthroplasty. J Arthroplast 2019;34:2080–4.
[41] Tai TW, Lin TC, Ho CJ, Kao Yang YH, Yang CY. Frequent dental scaling is associated with a reduced risk of periprosthetic infection following total knee arthroplasty: a nationwide population-based nested case-control study. PLoS One 2016;11:e0158096.
[42] Lampley A, Huang RC, Arnold WV, Parvizi J. Total joint arthroplasty: should patients have preoperative dental clearance? J Arthroplast 2014;29:1087–90.
[43] Barrington JW, Barrington TA. What is the true incidence of dental pathology in the total joint arthroplasty population? J Arthroplast 2011;26:88–91.
[44] Wei J, He L, Weng F, Huang F, Teng P. Effectiveness of chlorhexidine in preventing infections among patients undergoing cardiac surgeries: a meta-analysis and systematic review. Antimicrob Resist Infect Control 2021;10:140.
[45] Bardia A, Blitz D, Dai F, Hersey D, Jinadasa S, Tickoo M, et al. Preoperative chlorhexidine mouthwash to reduce pneumonia after cardiac surgery: a systematic review and meta-analysis. J Thorac Cardiovasc Surg 2019;158:1094–100.
[46] Lockhart PB, DeLong HR, Lipman RD, Abt E, Baddour LM, Colvin M, et al. Effect of dental treatment before cardiac valve surgery: systematic review and meta-analysis. J Am Dent Assoc 2019;150:739–47 [.e9].
[47] Omori C, Ekuni D, Ohbayashi Y, Miyake M, Morita M. Quasi-randomized trial of effects of perioperative oral hygiene instruction on inpatients with heart diseases using a behavioral six-step method. Int J Environ Res Public Health 2019;16:4252.
[48] Mincer RC, Zahr RH, Chung EM, Kubak B, Sung EC. Pre-cardiac dental treatment does not increase the risk of adverse events. J Oral Maxillofac Surg 2022;80:22–8 [Erratum in: *J Oral Maxillofac Surg.* 2022;80:785].
[49] Osako R, Matsuda Y, Itohara C, Sukegawa-Takahashi Y, Sukegawa S, Okuma S, et al. Relationship between oral bacterial count and postoperative complications among patients with cardiovascular disease treated by surgery: a retrospective cohort study. Healthcare 2021;9:850.
[50] Rao NR, Treister N, Axtell A, Muhlbauer J, He P, Lau A, et al. Preoperative dental screening prior to cardiac valve surgery and 90-day postoperative mortality. J Card Surg 2020;35:2995–3003.
[51] Suzuki H, Matsuo K, Okamoto M, Nakata H, Sakamoto H, Fujita M. Preoperative periodontal treatment and its effects on postoperative infection in cardiac valve surgery. Clin Exp Dent Res 2019;5:485–90.
[52] Bergan EH, Tura BR, Lamas CC. Impact of improvement in preoperative oral health on nosocomial pneumonia in a group of cardiac surgery patients: a single arm prospective intervention study. Intensive Care Med 2014;40:23–31.
[53] Safdar N, Crnich CJ, Maki DG. The pathogenesis of ventilator-associated pneumonia: its relevance to developing effective strategies for prevention. Respir Care 2005;50:725–39 [discussion 739-41].
[54] Messika J, La Combe B, Ricard JD. Oropharyngeal colonization: epidemiology, treatment and ventilator-associated pneumonia prevention. Ann Transl Med 2018;6:426.
[55] Lockhart PB, Durack DT. Oral microflora as a cause of endocarditis and other distant site infections. Infect Dis Clin North Am 1999;13:833–50 [vi].
[56] Zeng BS, Lin SY, Tu YK, Wu YC, Stubbs B, Liang CS, et al. Prevention of postdental procedure bacteremia: a network meta-analysis. J Dent Res 2019;98:1204–10.
[57] Mirabile A, Numico G, Russi EG, Bossi P, Crippa F, Bacigalupo A, et al. Sepsis in head and neck cancer patients treated with chemotherapy and radiation: literature review and consensus. Crit Rev Oncol Hematol 2015;95:191–213.
[58] Miyashita M, Kamijo R, Gibo A, Yoshimura N, Kurita H. Changes in the prevalence of oral bacteria detected in blood cultures before and after the introduction of insurance coverage for perioperative oral management. J Jpn Soc Dent Med Compromised Patient 2015;24:2–8 [[Japanese literature with English abstract]].
[59] Kajihara R, Sakai H, Han Y, Amari K, Kawamoto M, Hakoyama Y, et al. Presence of periodontitis may synergistically contribute to cancer progression via Treg and IL-6. Sci Rep 2022;12:11584.
[60] Goff DA, Mangino JE, Glassman AH, Goff D, Larsen P, Scheetz R. Review of guidelines for dental antibiotic prophylaxis for prevention of endocarditis and prosthetic joint infections and need for dental stewardship. Clin Infect Dis 2020;71:455–62.
[61] Hong CHL, Hu S, Haverman T, Stokman M, Napeñas JJ, Braber JB, et al. A systematic review of dental disease management in cancer patients. Support Care Cancer 2018;26:155–74.