REVIEW ARTICLE

Oral Health and Cardiac Rehabilitation: A Scoping Review

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ABSTRACT

This scoping review aimed to gain an insight into the oral health status, behaviour, knowledge, and risk among cardiovascular patients, as well as to explore challenges and to make a recommendation concerning oral health and cardiovascular patients. It focused on four key areas, namely oral health status, behaviour, knowledge, and associated risk factors. Relevant studies were searched using a combination of keywords and related search terms. Four available databases were used; EBSCOhost, Scopus, Proquest, and Pubmed to identify the relevant studies. A total of 789 papers were screened and duplicated papers were removed, 28 papers were retrieved for full-text review. It was found that most cardiovascular patients have poor oral health, while their oral health behaviour and knowledge were at a fair level. There are a limited number of studies assessing oral health conditions during cardiac rehabilitation. In general, protocol and guidelines about the importance of oral health care for cardiovascular patients are still lacking. Having good oral health has potential impacts in reducing the risk of CVD. Future research is warranted with potential intervention approaches to improve oral health conditions among cardiovascular patients, thus reducing the risk of CVD.

INTRODUCTION

Cardiovascular diseases (CVD) are disorders of the heart and blood vessels and the leading cause of death worldwide. Heart attack and stroke are the most common cause of mortality, representing 85% of the total death. The incidence of CVD is often associated with an unhealthy lifestyle and undesired health behaviours.[1] Modifiable risk factors can be modulated through medical interventions and changes in lifestyle behaviour. Therefore, primary and secondary prevention management are essential to reduce the burden of the disease and the mortality rate. Thus, 'cardiac rehabilitation' is one of the crucial components in cardiovascular management and there is evidence of its health benefits. Cardiac rehabilitation is systematically programmed and it provides a comprehensive approach to health care needs including health education, risk modification, and psychology components.[2] It has been proven to reduce mortality and morbidity while improving the quality of life, exercise capacity, and psychological well-being.[3]

Periodontal diseases are a potential source of chronic inflammation and a risk factor for coronary heart disease.[4] The increased number of oral bacteria is often associated with gingivitis and periodontal disease, which all lead to inflammation and elevate pro-inflammatory cytokines systemically, thus triggering the atherosclerosis process and the increased risk of cardiovascular diseases.[5] A microbiology study reported that oral bacterial were detected at high frequencies in cardiovascular specimens.[6] Thus, it was suggested that the specific oral bacterial species could be related to bacteraemia and one of the potential causative factors for the development of cardiovascular diseases.

METHODS

The review search was conducted as described by Arksey and O'Malley (2005). The databases used were EBSCOHost, Scopus, Proquest, and Pubmed. The

key terms used were related to oral health and cardiac rehabilitation; oral health, periodontal disease, periodontitis, periodontal treatment, oral health education, oral health assessment, oral hygiene, dental and cardiovascular, heart, cardiac rehabilitation, or cardiovascular prevention. Potentially relevant papers relating to the search questions (i.e. oral health status, behaviour, knowledge, and risk) were screened accordingly before the full texts were retrieved and the key information from each article was recorded.

RESULTS

A total of 789 studies were retrieved and one from a cross-reference searched, out of which 28 were identified for a full-text review (Figure 1). This review was sorted into five main aspects; i) oral health status, ii) oral health behaviours, iii) oral health knowledge, iv) associated risk factors of cardiovascular diseases, v) challenges and recommendations related to oral health and cardiovascular patients.

Oral Health Status among Cardiovascular Patients

Overall, the oral health status among cardiovascular patients was reported to be low.[7,8,9] The oral health status had been determined using various types of study designs and oral health parameters such as oral hygiene index (OHI), bleeding on probing (BOP), periodontal disease index (PDI), periodontal pocket depth (PPD), tooth loss, community periodontal index (CPI), loss of attachment (LOA) and decayed-missing-filled-teeth (DMFT).[10,11,12]

Coronary Heart Disease (CHD)

A study in Tehran on 150 cardiovascular patients particularly those with ischemic heart disease reported that 62% of them had periodontal diseases, with which 33% had comorbidities.[12] The mean scores of DMF surfaces and PDI index were significant differences in patients with hyperlipidaemia ($p<0.01$ and $p<0.001$ respectively). Meanwhile, the mean score of OHI was significantly

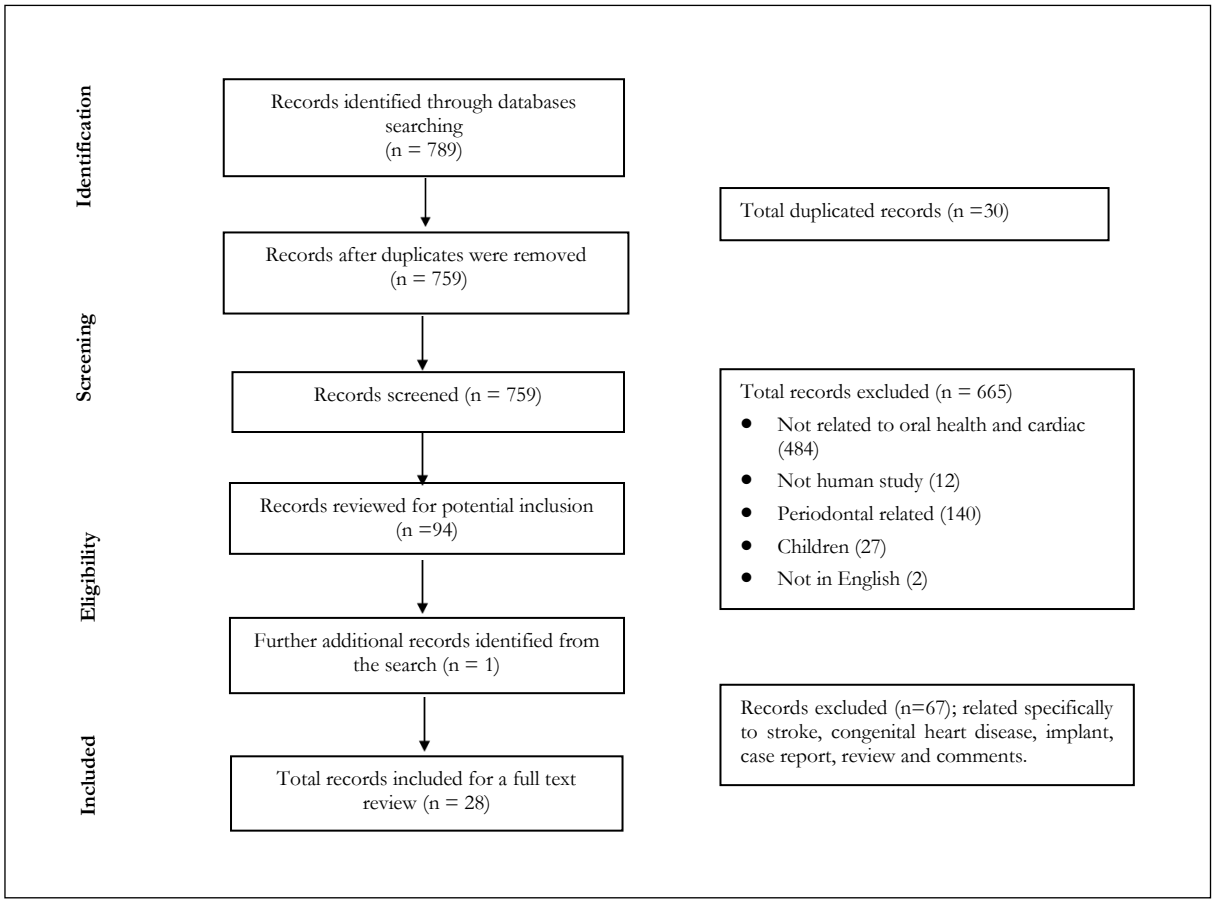

Figure 1: Study flow

different in patients with diabetes mellitus ($p<0.05$). Another study of 100 patients with CHD found that they had significantly higher oral mucosal lesions (e.g. ulceration and abscess), CPI, and LOA scores compared to the control group.[11] The patients also had a higher mean of DMFT and missing teeth compared to the latter, although statistically insignificant. A study on 45 CHD patients among Pakistani adults reported that BOP, PPD, and tooth loss were significantly higher in the study group compared to the control group.[10] These patients were systematically healthy with no other comorbidities and they were either non-smokers or ex-smoker (>6 months).

Recent Acute Coronary Heart Disease

A study reported by Oikarinen et al. (2009) among those with the first attack of unstable angina or acute MI,[13] where more extractions were required and higher cases of periapical lesions, vertical bone resorption, furcation involvement, and pocket depth ≥ 6mm compared to those without coronary heart disease (CAD). As for comorbidities, a higher prevalence of patients with CAD than that for those without CAD was attributed to smokers, those having hypertension and diabetes, and those with a high cholesterol level. A study on 300 middle-aged men aged <50 years following sudden cardiac deaths using the panoramic tomography index reported poor oral health conditions to be the main factor (OR=1.2, 95% CI=1.06-1.46, $p<0.01$).[14] In contrast, a study in Finland of 85 CHD patients found no significant association of dental indices with CHD, although these indices were found to be higher in CHD subjects compared to the control group.[15] Besides, poor oral health, and fewer teeth were also reported in patients with acute myocardial infarction ($p<0.001$).[16]

Pre-surgery

As for the pre-surgery intervention for cardiovascular patients, the oral health of the 75 subjects was reported to be poor and invasive dental treatments were required.[17] Most of the subjects were scheduled for valvuloplasty (41%), myocardial revascularisation (25%), and pacemaker implantation (16%). Among them, 58.6% required periodontal treatments, and 26.6% required restorative treatments. The other dental treatments required were surgical (18.6%), endodontic (12.0%), and pain and abscess (3.9%). Besides, a high percentage (88%) of the patients were found to have one or more systemic diseases, out of which more than half (54.5%) had arterial hypertension, while 20.0% had diabetes mellitus. A study on 226 cardiovascular patients, 54.4% of whom had CAD, while 45.6% had the valvular disease, reported that prior to surgery 67.2% of the CAD patients had active oral infections and 83.3% had periodontal diseases.[18] The overall oral health in CAD patients was found to be lower (27.6%) than that of those with valvular disease (49.5%). The DMFT index was also high with a median of 24 (IQR=17-32, $p<0.05$) among the CAD patients.

Another study of cardiovascular surgery patients reported that 68% of them had missing teeth related to caries, while 38.6% had one or more carious lesions with the mean of DMFT score of 1.28 ± 9.15.[8] The patients were also reported to have poor oral hygiene, where 61% of them had mean plaque index scores which ranged between 1.0-1.9. Approximately 69% of them required periodontal treatments, 53% prosthodontic treatments, and 39% restorative and endodontic treatments. No comorbidities were reported in the study.

Oral Health Behavior

A nationwide population-based study of nine-year follow-up with approximately 250,000 healthy adults with no CVD and aged ≥40 years reported a 9% reduction in cardiovascular events such as cardiovascular death, MI, stroke, and heart failure among those who brushed their teeth at least once a day.[19] Meanwhile, a regular dental visit for professional tooth cleaning (once or more a year) was found to be associated with a significantly lower risk of cardiovascular events by 14%. About 20% of the subjects had hypertension and 21.8% were current smokers.

Another study showed that approximately 89% of the patients either brushed their teeth once a day or did not brush their teeth regularly, and only 10.4% of them brushed their teeth twice a day.[8] Among those who brushed their teeth once a day or did not brush, 57% were

found did not brush their teeth daily. A high percentage of them did not use mouthwash (85.8%). Cleaning the interdental spaces using a toothpick (25.4%) was reported to be more often compared to that using floss (6.6%). More than half of them used toothpaste (66.9%) as a cleaning aid compared to tooth powder (15%), charcoal (7.5%), or crystal salt (3.7%). The same findings were reported by Rasouli-Ghahroudi et al. (2016), where about 42% of the participants were reported to brush their teeth once a day, 15% brushed their teeth twice or more a day and the remaining participants did not brush their teeth. The oral health practice among the patients was found to be low and it was significantly associated with the level of education ($p<0.001$) and financial status ($p<0.01$). Those with a higher education level (diploma and university) had a higher mean of practice score (52.8 ± 11.9 and 52.6 ± 16.6), compared to those with a lower education level (<49.0). Meanwhile, those with a very good financial status also had a higher mean of practice score (55.7 ± 12.4), compared to those with a good (43.8±14.8), and moderate and poor financial status (41.5±15.5). A significantly negative correlation between oral hygiene with practice ($r= -0.26$, $p<0.001$) was also reported.

Another study conducted on 318 CVD patients reported that approximately 58.8% of the patients had visited a dentist in the last 12 months, and 13.5% of them were reported to have not had their dental visit for more than two years.[20] About 60.4% of them were reported to clean their teeth or dentures twice or more per day. Most of them (90.9%) used fluoride toothpaste to brush their teeth and 34.6% used dental floss or other cleaning aids. This finding was similar to that by de Oliveira et al. (2010), where 62% of the participants were reported to visit a dentist at least every six months and 71% brushed their teeth twice a day. Those who rarely or never brushed their teeth comprised men (85.5%), smokers (48.5%), those with hypertension (31.6%), diabetes (6.7%), and obese (33.8%).

Oral health knowledge

Rasouli-Ghahroudi et al. (2016) reported that oral health knowledge was moderate among CVD patients and that there was a significant negative correlation between oral hygiene with knowledge ($r=-0.32$, $p<0.001$). This suggested specific programmes to be planned and executed to increase oral health knowledge for better oral hygiene conditions. Another study also reported that half of the patients had moderate oral health knowledge with the mean of the correct response of 6.2% out of 12 knowledge items.[20] Those with valvular conditions were found to receive more information on oral health compared to those with other cardiovascular diseases. The correlation between the patient's knowledge and oral health information received in the cardiovascular setting ($r=0.121$, $p=0.031$) and the patient's level of education ($r=0.115$, $p=0.041$) was weak. The poor dissemination of oral health promotion and oral health information from the health care providers was identified to be the main reasons associated with the poor oral health knowledge. The knowledge concerning the association between oral health and heart disease was found to be fair, and none of t he participants was aware of the risk and complications of poor oral health in particular with infective endocarditis.[8]

RISK OF CVD

Oral hygiene

A national survey on tooth brushing behaviour conducted in Scotland with 11,000 participants found that those with poor oral hygiene (never or rarely brushed their teeth) had an increased risk of a CVD event (HR=2.3, 95% CI=1.8-3.1, $p<0.001$).[21] The association remained (HR=1.7, 95% CI=1.3-2.3, $p<0.001$), even after adjustment for sociodemographic background, BMI, smoking, hypertension, and diabetes.

Unsatisfactory oral health among preoperative surgery of cardiovascular patients was 12 times more likely to develop postoperative pneumonia compared to those who had satisfactory oral hygiene ($p<0.001$).[18] The presence of tongue plaque and poor dentures hygiene in the preoperative period significantly increased the chance of postoperative pneumonia among cardiovascular surgery patients. Thus, early assessments of oral health

status and early intervention during the preoperative period for patients planned for a cardiovascular surgery are expected to reduce postoperative complications.

Number of Teeth

A twelve-year study of approximately 100,000 participants with no CVD diseases at the baseline showed that those who were edentulous or had only up to 10 teeth had a significantly higher risk of CHD (men: RR=1.36, 95% CI=1.11-1.67, p<0.05, women: RR=1.64, 95%CI=1.31-2.05, p<0.05).[22] This finding was in agreement with that in a 6-year follow-up study of 45,000 health professional male subjects with no CHD at the baseline.[24] Subjects with less than 10 teeth were found to have a higher risk of CHD (RR=1.32, 95%CI=0.98-1.77). Meanwhile, a study among 256 Finnish people with a 15-year follow-up reported that each increment of 10 teeth from the edentulous condition was associated with a 27% improvement in the CAD survival rate.[24]

A national study in Korea with over four million subjects and a seven-year follow-up reported that tooth loss was associated with increased risks for CVD, and five or more missing teeth substantially increased the risks for cardiovascular outcomes.[25] Each missing tooth was associated with a 1% increased risk in MI, a 1.5% increase in heart failure and stroke, and a 2% increase in mortality.

The same associations were also reported in a study in Japan with about 700 subjects, where edentulous individuals and those with less than 20 teeth were found to have increased risks for CHD.[26] Tooth loss has also been associated with carotid artery calcification in a study population of 175 participants (p<0.001).[27] The same finding was reported by Bokhari et al., (2011), where BOP (OR=1.027, 95%CI=1.01-1.05) and tooth loss (OR=1.22, 95%CI=1.05-1.42) were found to be factors associated with increased risk to CHD.

Periodontal Disease

A 17-year cohort study among American adults reported that one in four of the subjects had an increased risk of CHD if they had periodontitis (RR=1.72, 95% CI=1.10-2.68).[28] Another study showed that subjects with a positive periodontal history were found to have a higher risk of CHD (RR=1.67, 95%CI=1.03-2.71).[23] In a 10-year follow-up population-based study in Korea, the risk of cardiovascular events was found to be higher when a subject was diagnosed with periodontal disease, having a higher number of dental caries, or tooth loss.[19]

Cytokines

A study among 92 patients within 48 hours of acute myocardial infarction (AMI) showed that the serum and salivary C-reactive protein (CRP) levels significantly increased among the AMI patients (p<0.001). They were also found to have significantly poor oral health and had fewer teeth.[16] In a subsample study with over 4,500 participants reported that those having poor oral hygiene (brushing less than once a day) had an increased concentration of CRP (β=0.04, 95%CI=0.01-0.08, p<0.05) and fibrinogen (β=0.08, 95%CI=−0.01-0.18, p<0.05), thus increasing the risk of CVD.[21] The level of periodontal disease inflammation alone is enough to create a systemic inflammatory response.[30] The increase of CRP response of the periodontal disease may significantly be related to the increase of CRP serum level.[30,31] A study on dysrhythmia subjects found that those with a high mean CRP serum level had a significantly higher number of sites with root caries compared to a low CRP group (p<0.001), and those with one or more number of sites with root caries had a significantly higher likelihood of onset of cardiovascular dysrhythmia (OR=5.84, 95%CI=1.09-31.31).[32] Thus, this may increase the likelihood of morbidity and mortality related to a cardiovascular event.[33]

Oral Prostheses

As more people with increased risks for CVD had fewer teeth or no teeth, the demand for dentures has increased. A study showed that 65% of cardiovascular patients scheduled for surgery were found to have debris and 63% had calculus on their dentures.[34] A 15-year study on 250 CAD subjects in Finland found that those who had

removable partial dentures and natural teeth with a mean number of teeth of 15.4 had a better survival rate (HR=0.75, 95% CI=0.22-2.56, p>0.05) compared to those with all-natural teeth.[35] Those who had partial and full dentures with a mean number of teeth of 7.4 had a shorter lifespan (HR=1.99, 95%CI=1.05-3.81, p<0.05) compared to those with natural teeth. Maintaining good hygiene for both natural teeth and dentures will reduce oral inflammatory foci and increase cardiovascular survival rates. The treatment of denture-related stomatitis with local oral antifungals for three weeks helps to significantly improve endothelial function after a 2-month follow-up.[34] With regards to fixed prosthodontics, a study by Caplan et al. (2009) found that subjects who had one or more crowns had an increased risk for CHD (OR=1.88, 95% CI=1.33-2.64, p<0.05) compared to those who did not have crowns. This is related to the number of teeth that had undergone root therapy, often followed by the provision of a crown.

Endodontic Treatment

A study with a 32-year follow-up on approximately 700 subjects showed that the incident lesions of endodontic origin were significantly associated with time to CHD diagnosis for subjects ≤ 40 years old. The time to CHD diagnosis was faster for every three endodontic lesions in a year (HR=1.4, 95%CI=1.1-1.8, p<0.05). As for those >40 years old, there was no statistically significant association observed between lesion of endodontic origin and CHD diagnosis. The same researchers reported on another study with over 6,500 subjects that those who had ≥25 teeth and had endodontic treatments two or more times had an increased risk for CHD (OR=1.62, 95% CI=1.04-2.53, p<0.05) compared to those who never had endodontic treatments.[37] There was also a significant difference for those subjects who had ≤24 teeth and reported having had endodontic treatment two or more times, had an increased risk for CHD (OR=1.74, 95% CI=1.12-2.69, p<0.05). In contrast, an earlier study on approximately 1000 women in Sweden reported that there was no significant association between endodontic-treated teeth and teeth with the periapical disease with CHD, although the root-filled teeth showed an increased likelihood of CHD.[38] As revealed from this study, age and tooth loss were the significant factors associated with CHD (OR=1.07, 95%CI=1.03-1.12, p<0.05) and (OR=2.70. 95%CI=1.49-4.87, p<0.05), respectively.

Challenges and Recommendations of Oral Health and Cardiovascular Patients

Oral health care guidelines have been established for those having congenital and rheumatic heart diseases, and prosthetic valves to prevent bacterial endocarditis.[39] However, the awareness of the importance of oral health and recommended oral health care practices is lacking.[40] Oral hygiene care interventions, for example, tooth brushing and cleaning of the tongue during the preoperative stage help to improve the oral health status among cardiovascular surgery patients. A chlorhexidine gluconate 0.12% oral rinse was also prescribed to be used twice a day until the day of the surgery.

Improved oral hygiene behaviours, tooth brushing, and regular dental visits have been shown to lower the cardiovascular risk originating from poor oral hygiene.[19] Hence, oral health education and guidelines for cardiovascular patients must be highlighted to increase awareness and health behaviour. Lack of awareness among cardiovascular patients may stem from inadequate dissemination of information about oral health. It is important to inform patients who are at risk and the association between heart disease and periodontal conditions.[41] Efficient oral health programmes are recommended to be planned and executed to promote good oral health behaviour among cardiovascular disease patients. It is also recommended for the health care providers to communicate effectively among related disciplines for patients' benefit. Thus, early dental and medical assessments and interventions are suggested, to reduce the risks of a cardiovascular attack.

CONCLUSION

The findings reaffirmed that most CVD patients had an unsatisfactory oral health status and improved oral health behaviors may help to reduce the risk of CVD.

Effective implementation of oral health care during cardiac rehabilitation may enhance health benefits, reduce mortality and improve quality of life.

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