

The heart of it: dental care and cardiothoracic surgery

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Key points

Oral and cardiac diseases are common and can be associated with each other.

Dental care to reduce oral infection risk is integral to pre-operative planning for cardiac surgery, particularly valve replacement and where prosthetic material will be used.

Awareness of the consequences of cardiac diseases for dental intervention is necessary to provide safe dental care.

Abstract

Both dental and cardiovascular disease are prevalent in the general population, have common risk factors and may be closely associated.

Following cardiothoracic surgery, patients may be higher risk for developing infective endocarditis (IE) than the general population. Before cardiothoracic interventions, it is common practice for a dental assessment to be carried out and any necessary dental treatment provided. This aims to reduce the risk of IE arising from dental sources and avoid dental pain or infection during the peri- and post-operative period. There is little guidance on which treatments should be performed and when.

Many patients with cardiac disease may have dental treatment provided safely in primary care. However, there is often a need to consider additional factors, including bleeding risk, condition stability or medication interactions. Dental teams must have an awareness of the implications of cardiac disease and provide reasonable adjustments to care provision where necessary, ensuring patient safety.

This article proposes a protocol for dental management of patients awaiting cardiothoracic surgery and explores important considerations for dental care in this patient group.

Introduction

Around 7.6 million people live with a heart or circulatory disease in the UK, with coronary

heart disease being the second largest cause of death in 2022.¹ Congenital heart disease (CHD) is the most common birth defect in children² (approximately 8/1,000, excluding bicuspid aortic valve) and improving mortality rates have led to an increasing number of adults with CHD.³ Annual costs related to cardiovascular disease (CVD) for healthcare alone in the UK are estimated at £10 billion; when considering the wider economy, including disability, informal costs and premature death, this rises to £25 billion.¹

Dental disease is also highly prevalent in the UK, with 31% of adults having obvious caries and 45% having periodontal disease.⁴ Studies have reported a higher prevalence of dental disease in those with CHD compared to healthy controls.^{5,6,7}

Trends indicate the proportion of older adults in the UK population is growing,⁸ with an increased prevalence of acquired CVD in older groups.⁹ Concurrently, older adults are retaining their natural dentition for longer⁴ and are therefore more likely to require operative dental interventions. Dental

practitioners are therefore likely to see a significant number of patients with varying type and severity of heart disease.

Infective endocarditis

Infective endocarditis (IE) is rare but is associated with significant morbidity and mortality. It is characterised by microbial colonisation of the endocardium occurring, which may arise following bacteraemia in those with predisposing conditions, such as valvular heart disease, hypertrophic cardiomyopathy and structural heart disease.¹⁰ A subgroup of these patients are considered at particularly high risk: those with a history of IE, valve replacement or structural heart defects (excluding repaired septal defects after endothelialisation of the closure device).¹¹ Antibiotic prophylaxis for invasive dental procedures may reduce the risk of IE. As a general consensus, it is advocated only for those at particularly high risk of IE when undergoing procedures requiring perforation of the oral mucosa or manipulation of the gingival or periapical areas.^{11,12}

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Table 1 Percutaneous transcatheter procedures

Percutaneous transcatheter procedure		Dental considerations
Percutaneous transcatheter heart valve interventions	The most established of these techniques is transcatheter aortic valve implantation (TAVI) for the treatment of aortic stenosis, involving implantation of a prosthetic aortic valve via peripheral arterial access (most commonly the femoral artery). Current UK guidance recommends TAVI over conventional surgical aortic valve replacement (SAVR) in patients considered to be at high risk for cardiac surgery (often older patients or those with significant comorbidities). ¹⁷ While not included in standard surgical risk assessment scores, dental comorbidity is also likely to be significantly increased in this group. The rate of TAVI implantation in the UK is increasing rapidly, with just over 6,000 procedures performed in 41 centres in the UK in the years 2019–20. ¹⁸ Transcatheter pulmonary valve implantation has also become an established technique for management of pulmonary valve pathology, mainly performed for those with CHD.	As with SAVR, IE is a recognised complication in patients with transcatheter valves. ¹⁹ This is reflected in the most recent European Society of Cardiology (ESC) guidelines on IE which include patients with transcatheter-implanted valves in the high-risk group for endocarditis. ¹² Antibiotic prophylaxis before invasive dental procedures is recommended for this group (Class 1 recommendation).
Percutaneous transcatheter techniques for the management of valve regurgitation ²⁰	The most common of these techniques is transcatheter edge-to-edge repair (TEER) for mitral regurgitation and more recently, tricuspid regurgitation, where a clip (or clips) is placed on the valve leaflets to reduce and ideally eliminate regurgitation. In the UK, these procedures remain limited to a small number of tertiary cardiac centres with a relatively small volume of cases. However, mitral TEER was approved for commissioning by NHS England in 2019 so numbers are likely to increase significantly in years to come.	Data on endocarditis risk in TEER repair patients is limited ²¹ but given that the procedure involves implantation of prosthetic material (the clip), it is reasonable to assume that these patients' risk of IE is not insignificant. For this reason, the latest ESC guidelines state that antibiotic prophylaxis before invasive procedures should be considered for TEER patients (Class IIa recommendation). ¹²
Percutaneous transcatheter cardiac structural interventions	Transcatheter closure has become standard treatment for patients with atrial septal defect, with open heart surgery now reserved for a minority of patients with very large and/or complex defects. Transcatheter closure of the left atrial appendage can be performed in patients with atrial fibrillation at high risk of thromboembolism, if anticoagulant therapy is contraindicated.	While the presence of prosthetic material in the heart following these procedures is associated with an increased risk of IE, this risk generally occurs in the first six months after device implantation while the device is undergoing endothelialisation. ²² The ESC recommends antibiotic prophylaxis only for the first six months following device implantation. ¹²
Percutaneous coronary artery intervention (PCI)	PCI is now the standard method of revascularisation for patients with symptomatic obstructive coronary artery disease. Commonly performed under local anaesthesia via peripheral arterial access, it involves balloon dilatation of blocked coronary arteries with or without the use of an expandable stent. ²³ Coronary artery stents are often coated with a drug such as sirolimus or paclitaxel, which inhibits cellular proliferation (drug eluting stent [DES]). Excessive cell proliferation within the stent can produce significant obstruction to flow and cause recurrent angina symptoms. DES are associated with significantly lower rates of recurrent angina and further revascularisation than stents with no drug coating (bare metal stents). Until the stent becomes fully endothelialised within the coronary artery, there is a risk of stent thrombosis (a potentially life-threatening complication) due to exposure of the stent material to blood clotting factors. To reduce this risk, patients are commonly prescribed dual antiplatelet therapy (DAPT) (usually aspirin plus a second agent, such as clopidogrel, ticagrelor or prasugrel) following stent insertion until approximately one-year post-PCI. Thereafter the patient is maintained on a single antiplatelet agent (usually aspirin).	During the period of DAPT, there is a significant risk of acute stent thrombosis if one or both of the antiplatelet agents is interrupted, ²⁴ even on a temporary basis. Wherever possible, dental interventions requiring cessation of antiplatelet therapy should be delayed until completion of the recommended DAPT treatment period. The interventional cardiology team must be consulted for guidance on the safety of interruption of DAPT. While there are isolated case reports of infection of intracoronary stents, this is extremely rare and patients with stents do not require antibiotic prophylaxis.

The risks of adverse drug reactions and the development of antibiotic resistance must be carefully considered against the risk of IE during clinical decision-making. Emphasis must be placed on informed consent, shared decision-making and patient autonomy. Post Montgomery,¹³ there is increased onus on the clinician to inform patients about the potential benefits, 'material risks' and to consider information the patient would want to know in their individual circumstances. It is important that dental practitioners are familiar with the most recent guidance relating to IE and antibiotic prophylaxis.^{11,12}

Maintenance of oral hygiene and regular dental review are as important in preventing IE as antibiotic prophylaxis.¹⁴ It is understood that transient bacteraemia occurs not only after

dental procedures but also after normal daily activities, such as toothbrushing and interdental cleaning.¹⁵ Patients should be counselled on the risk posed by other non-medical procedures, such as tattoos and piercings.¹¹

Recent developments in cardiothoracic surgery

Adult cardiac surgery can be defined as a procedure involving the surgical opening of the thoracic cavity or pericardium. In the UK, the most commonly performed surgeries are coronary artery bypass graft, valve surgery, interventions involving the thoracic aorta or a combination of these procedures.¹⁶ Between 2021–2022, 24,807 adult heart operations were carried out in the UK.¹⁶

Over the last 10–15 years, major advances have been made in percutaneous interventions for valvular disease, coronary heart disease and structural heart defects. With increasing numbers of patients undergoing these interventions, it is important dentists are familiar with the implications they have for dental care (Table 1).

Dental assessment and treatment before cardiac surgery

Multiple sources support the optimisation of dental health before cardiac surgery. The European Society of Cardiology¹² recommends 'potential sources of dental sepsis should be eliminated at least two weeks before implantation of a prosthetic valve or

other intracardiac or intravascular foreign material, unless the latter procedure is urgent.²

As well risk for IE, odontogenic infections in the peri-/post-operative period may have catastrophic consequences, such as systemic spread or sepsis. Adverse outcomes may lead to increased morbidity, mortality and cost.²⁵ The presence of periodontitis may be associated with increased incidence of post-operative bacterial infections and longer hospital stays.²⁶ Successful peri-operative oral care has been shown to reduce levels of inflammation during the post-operative period.²⁷ Furthermore, addressing oral health before surgery may prevent dental treatment need during the immediate post-operative period, which can be complicated by anticoagulant therapy.²⁸

The Congenital Heart Disease Standards and Services Specification provides an example of standards necessary in adult CHD services in England.²⁹ It recommends:

- Evidence-based dental prevention advice at the time of CHD diagnosis
- Dental assessment as part of pre-procedure planning for elective cardiac surgery
- A clear referral pathway, facilitating timely urgent dental assessment for patients with CHD who have dental emergencies or suspected endocarditis.

Despite evidence to support pre-operative dental treatment, several studies have found no statistical significance in the rates of complications following cardiac surgery in patients who did or did not have dental treatment pre-operatively.^{30,31,32} A recent systematic review based on findings from observational studies concluded a lack of clarity as to whether dental treatment before cardiac surgery affects patient outcomes.³³ Morbidity and mortality following heart valve surgery was comparable in patients with and without untreated chronic dental infections both immediately, and within a six-month period.

What are the challenges in planning dental care for patients awaiting cardiac surgery?

There is a general lack of evidence for the extent of dental treatment needed to render an individual fit for cardiac surgery. Management of acute infections causing pain, suppuration, sinus tracts or removal of Grade III mobile teeth is advisable.³⁴

However, completing all dental treatment indicated may not be feasible or confer clear benefits in terms of improved post-operative outcomes.²⁸ A recent study by an oral surgery service in the UK reported a mean interval of 9.7 working days between referral for dental input and planned cardiac surgery.³⁵ In this short timescale, it is often not possible to treat all non-infected carious teeth, manage tooth wear, or see the results of periodontal treatment provision. From the authors' experience however, routine dental screening as part of cardiology outpatient clinics may help reduce longitudinal risk, identifying and signposting at-risk patients for dental care before any cardiothoracic surgery becomes imminent.

Decision-making can be complex and relies on excellent cross-specialty communication. Cardiothoracic surgeons may have limited understanding about the extent of dental treatment necessary for common dental conditions, success rates of such treatment, or time before benefits will be apparent. Likewise, dental teams may not appreciate the severity of patients' cardiac conditions, risks posed by providing dental treatment and time available before cardiac surgery. Unless patients can maintain their dentition once deemed dentally fit for surgery, assessment and treatment may not have significant long-term benefit. For example, an individual with immaculate oral hygiene and 'currently stable' periodontitis may soon become 'currently unstable' during an intensive therapy unit stay with poor or difficult oral healthcare.

There are current access challenges affecting NHS primary dental care, exacerbated by the COVID-19 pandemic³⁶ and a workforce move away from NHS dentistry.³⁷ Patients may be less likely to be registered with a general dental practitioner (GDP) and may have more potential for undiagnosed oral disease when presenting for cardiac interventions.

Previous research has been mostly observational in nature.^{28,33} Confounding factors linking dental and cardiac disease make design and implementation of randomised controlled trials challenging. Difficulty achieving randomisation and the potential for bias is likely to affect the validity of results. Prospective, multicentre trials with novel, pragmatic design are needed to identify appropriate peri-operative management.

What are the risks of providing dental treatment for patients awaiting cardiac surgery?

The risks of dental treatment before cardiac surgery relate to the physiological insult dental interventions may cause for the cardiovascular system and any subsequent delay in cardiac surgery while treatment is carried out or healing occurs.

Patients with limited cardiac function are less able to adapt to physiological stresses triggered by dental procedures.³⁸ This may contribute to the risk of a major adverse cardiovascular events (MACE), such as myocardial infarction, stroke, or acute heart failure.³⁹ The risk of MACE is also influenced by a patient's anxiety levels and the invasiveness of proposed dental treatment.⁴⁰ It is therefore important that dental treatment is carried out in an appropriate environment. For some, with severe cardiac dysfunction, treatment should be in a hospital setting with cardiac monitoring.^{38,41}

Research suggests there may be increased risk of stroke or myocardial infarction in the weeks following an invasive dental procedure, possibly due to an associated systemic inflammatory response and endothelial dysfunction.⁴² Furthermore, tissue damage may initiate a prothrombotic state which could increase the risk of peri-operative thrombosis, ischaemia and arrhythmia.^{43,44}

When should we provide dental treatment for patients due to have cardiac surgery?

Timing of treatment is contentious, with reports of the ideal timeframe being three months before cardiac interventions to minimise the likelihood of recurrent infection.⁴⁵ In many cases, the urgency of cardiac management may preclude this. Approximately one week to allow wound closure is recommended to reduce infection risk.²⁸

Concomitant dental and cardiac treatment are possible. Historically, this has been rejected due to the risk of bacteraemia and associated endocarditis. However, research suggests no significant difference in the incidence of IE or patient outcomes between those managed conventionally (dental treatment before valve replacement) and those having both cardiac and dental surgery under the same general anaesthetic (GA).^{46,47} Concomitant surgery may be considered for those who would

Fig. 1 Suggested pre-surgical dental screening protocol

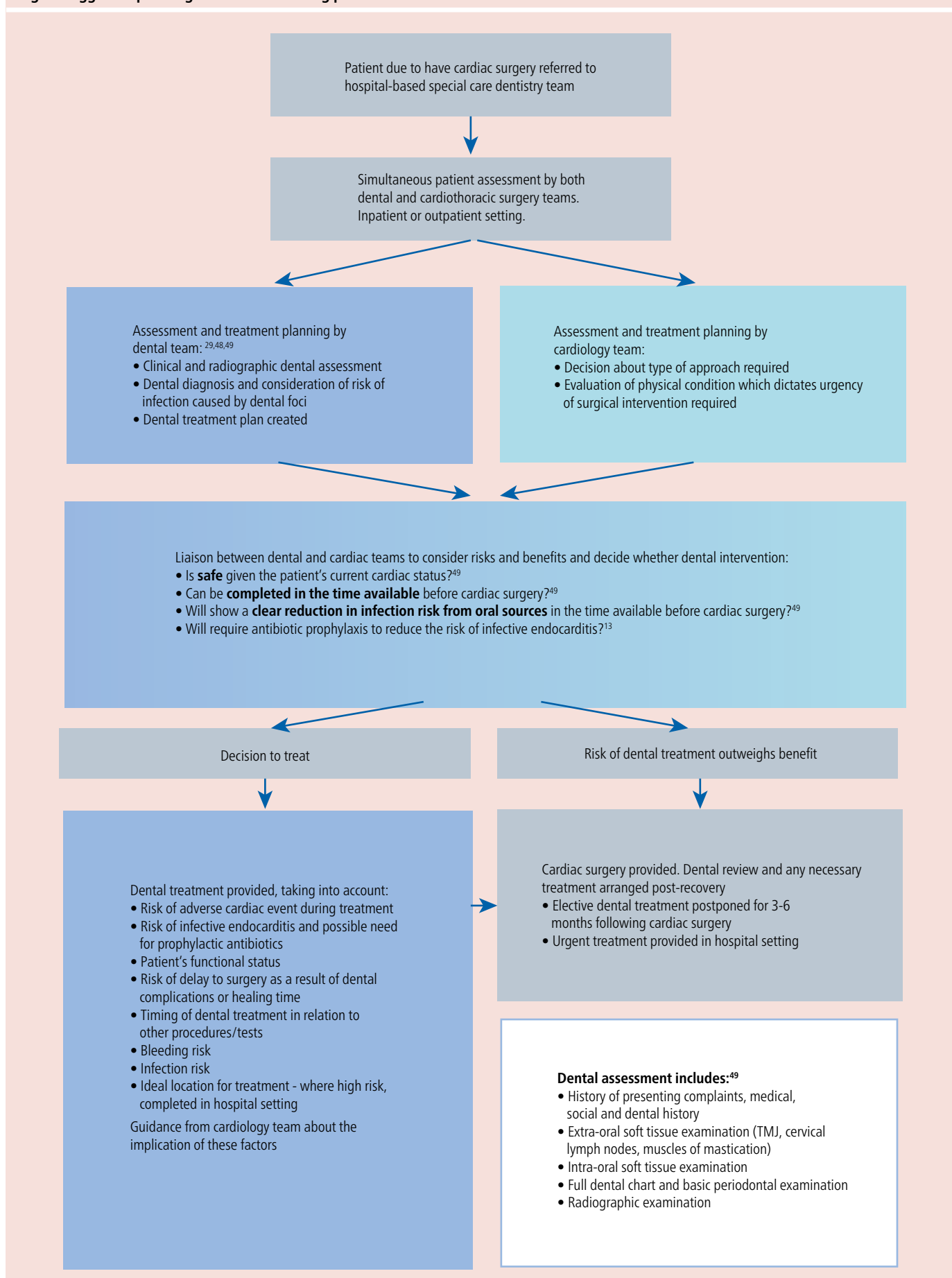


Table 2 Considerations for provision of safe dental care

Analgesia	<ul style="list-style-type: none"> Avoid non-steroidal anti-inflammatory drugs (NSAIDs), which may increase the risk of coronary heart disease.⁵² Avoid NSAIDs in patients taking anticoagulants or antiplatelet drugs
Antibiotic prophylaxis	<ul style="list-style-type: none"> Follow available guidance for patients at high risk of IE undergoing at-risk dental procedures^{11,12}
Anticoagulant therapy	<ul style="list-style-type: none"> Follow general principles of staging initial treatment, plan treatment early in the day/week Consider local haemostatic measures, such as packing and suturing⁵⁰ Follow drug-specific guidance⁵⁰
Chair positioning	<ul style="list-style-type: none"> Some patients may not be able to tolerate a supine position (eg patients with orthopnoea and heart failure)
Emergency management	<ul style="list-style-type: none"> Have glyceryl trinitrate available for potential ischaemic chest pain Maintain competencies in basic (and immediate) life support
Local anaesthetic	<ul style="list-style-type: none"> Local anaesthetic containing adrenaline is likely to be safe for many patients with CVD⁵³ (maximum dose two cartridges 1:100,000 adrenaline)⁵⁴ Slow infiltration and careful aspiration to avoid intravascular injection Care for those with increased bleeding risk 4% articaine buccally is as effective as 2% lidocaine inferior dental block for mandibular molars⁵³ and may reduce haematoma and inadvertent intravascular injection Avoid use of gingival retraction cord impregnated with adrenaline due to rapid absorption⁵⁴
Stress reduction measures	<ul style="list-style-type: none"> Open communication about anxieties Short appointments Effective local anaesthesia including use of topical anaesthetic Careful consideration of: <ul style="list-style-type: none"> Pre-medication Inhalation sedation using nitrous oxide and oxygen Intravenous sedation or general anaesthesia Intravenous sedation for ASA III patients is safest provided in a theatre setting with access to urgent medical care⁵⁶ Effective post-operative pain control Cognitive behavioural therapy
Timing of dental treatment	<ul style="list-style-type: none"> High-risk patients may not be suitable for dental treatment. Seek advice or postpone treatment when there is a history of: <ul style="list-style-type: none"> Unstable angina (occurring at rest) Myocardial infarction in the last 3–6 months – decision-making depends on residual symptoms and complications experienced Dual antiplatelet therapy Urgent care should be provided for this group. Be as conservative as possible, focusing on pain relief, infection control or control of haemostasis. Treatment may be best performed in a hospital dental clinic with additional precautions⁵⁴
Prevention	<ul style="list-style-type: none"> Counsel patients on the importance of maintaining oral hygiene and attending for regular dental appointments Promote healthy lifestyles and risk reduction measures, such as diet, exercise, smoking cessation, weight management and signpost towards services where needed⁵⁷

benefit from dental treatment but may be too unstable to allow delayed cardiac surgery or a repeat GA with its associated risks.²⁸ A prospective study on a larger scale would be necessary before making recommendations for concomitant dental and cardiothoracic surgery.

Suggestions for dental care of patients awaiting cardiac surgery

Referral pathways for dental assessment and treatment before cardiac surgery vary.⁴⁸ It is important that medical teams recognise the need for dental assessment and liaise with hospital-based services, community services or GPs, allowing access to dental care in the most appropriate setting. Multiple

patient factors influence where dental care is provided, including dental registration, prior dental attendance, oral health status, urgency of the planned cardiac intervention and the complexity of other comorbidities. Dental team skillset, service capacity and proximity to specialist medical care must be considered.

Given the paucity of evidence, collaborative working and joint decision-making between cardiac and dental teams is recommended, taking into account individual patient factors. It is important to consider the timescales involved and likely outcome of dental interventions, then weigh these factors against the cardiac condition of the patient, the safety of providing dental treatment and the urgency of cardiac surgery.⁴⁹

A suggested protocol for dental assessment (Fig. 1) would include a thorough history of dental symptoms and medical, social and dental histories, alongside a comprehensive clinical examination, including extra- and intra-oral soft tissue examination, full dental charting, assessment of oral hygiene, basic periodontal examination and assessment of tooth mobility. Radiological imaging should be provided based on clinical justification. Consideration should also be given to additional special tests, including pulp vitality testing, tooth percussion, bite testing and tooth transillumination.^{48,49}

Regardless of assessment outcome, all patients should be counselled on the importance of regular dental reviews, the need for excellent oral hygiene and limiting frequency of sugary intakes, along with the potential links between oral and cardiac health, particularly IE risk.^{48,49}

Considerations when providing dental care for patients with cardiac disease

As discussed previously, patients with severe or uncontrolled disease are likely to be at an increased risk of MACE during non-cardiac surgery.⁵¹ Although routine dental treatment is thought to confer less risk than other surgical procedures, the risk assessment principles described in medical guidelines can be used as a basis for decision-making before dental treatment.^{40,41}

An algorithm such as that designed by Ransford *et al.* (2018),⁴¹ may be helpful to identify patients at higher risk of a MACE who may benefit from specialist dental input or treatment being postponed or provided in a hospital setting, allowing liaison with the cardiology team. There are many factors to consider during provision of dental care in this cohort (Table 2).

Conclusion

For those with cardiac disease, patient suitability for dental treatment should be assessed on an individual basis, considering patient factors, practitioner training and experience, and treatment environment. Patients should be provided with sufficient information to make informed decisions.

The provision of dental treatment before planned cardiac surgery should be evaluated individually and the extent of treatment provided must be proportionate. Treatment before cardiac intervention may

be ideal; however, delaying cardiac surgery to provide dental treatment may have serious health consequences. Wherever possible, significantly infected teeth should be extracted; however, extensive treatment or removal of 'less than perfectly healthy' teeth are of uncertain benefit.

Development of collaborative, evidence-based treatment recommendations for both medical and dental professionals may reduce peri-procedural risk for both dental and medical interventions. The dissemination of standardised protocols, based on expert opinion, alongside the available evidence, goes some way towards achieving this goal. With the formalisation of integrated care services and integrated care boards brought about by the Health and Care Act 2022,⁵⁸ commissioning of dental and cardiothoracic services will be delegated to these new bodies. It is hoped this will lead to multidisciplinary working and collaboration between dental and cardiology teams, optimising dental care provision for this patient group.

Ethics declaration

The authors declare no conflicts of interest.

Author contributions

Claire Potter: first author (majority of work in collaboration with Zoe Ritson). Zoe Ritson: second author (majority of work in collaboration with Claire Potter). Tim Irvine: author of section about percutaneous transcatheter procedures, provided guidance and proofreading. Kate Ohlson-Turner: collaborating author for a first draft of this work, providing insights relating to oral surgery. Graham Walton and Louise Coats: provided guidance and proofreading.

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