Environmental sustainability and travel within the dental practice

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Key points

Highlights that more than sixty percent of dentistry's carbon emissions originates from travel. Travel affects air quality, nitrogen oxides and particulate matter, which in turn impacts on overall health.

Demonstrates how dental travel causes the loss of 325 quality-adjusted life years, at a cost to health and society of around £17.5 million.

Suggests the dental team needs to increase prevention, decrease the number of physical appointments and encourage active travel and use of public transport.

Abstract

A significant amount of dentistry's carbon emissions originate from travel (64.5%). Dental-associated travel affects air quality, releasing over 443 tonnes of nitrogen oxides (NOx) and 22 tonnes of particulate matter (PM2.5) annually. This reduction in air quality reduces over 325 quality-adjusted life years (QALY) per year. Wider health impacts associated with noise and traffic incidents doubles the impact on health in QALYs. Dental procedures that require shorter appointment times have disproportionately higher emissions due to patient travel. The dental team can reduce appointment times by combining visits for family members or combining operative procedures, or reducing appointment frequency based on patient risk. Community oral health programmes and preventive programmes reduce travel emissions. The number of physical dental appointments can be reduced using information technology such as global positioning systems (GPS), telemedicine and teleconferencing. The mode of travel is important, with the air and carbon emissions generated by active travel negligent compared to a private car. Travel plans can help encourage active travel, as can flexible working hours, cycle to work schemes, cycle racks and shower facilities. Practices should consider purchasing locally sourced or sustainably transported goods and, ideally, use local dental laboratories.

Introduction

This paper forms part of a series of papers, seven in total, which have been requested by colleagues to help them understand sustainability as it relates to dentistry. Travel and transport are the focus of this paper and consideration is given to how the dental team can both influence patient and staff travel and purchase goods with reduced travel emissions. It is the authors' hope that this series of papers stimulates interest, debate and discussion and, as well as being economically responsible, ultimately motivating and inspiring dentistry to be more socially and environmentally sustainable, which will in turn help promote health and illness prevention.

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The contribution of dentistry to the travel footprint

Travel is a significant contributor of carbon emissions and air pollution within dentistry because patients often need to travel several times to receive a course of treatment and, based on patient surveys, usually come by car.[1] Procedures that involve small amounts of time at the dental clinic have a disproportionately high carbon emissions rate. This is because an appointment, such as a basic examination, can require significant patient travel (within England the average return journey to a dental practice is 7.57 miles) but otherwise uses little resource, with only a small amount of energy to heat the practice allocated for an examination (compared with a lengthier restorative appointment) and limited resources to sterilise and clean the instruments etc.[1]

Dentistry and associated carbon emissions

Dentistry is different to many other areas of the NHS because a significant amount of its carbon emissions originate from travel, both staff travel (commuting to work and travelling for work purposes) and patient travel (travelling to and from the dental surgery for treatment). In the calculation, performed on behalf of Public Health England (PHE) and based on travel information from FP17 claims from the NHS Business Services Authority (NHSBSA), the carbon emissions from travel associated with dentistry were 64.5% of the total amount. This is considerably more than the contribution of travel to the carbon footprint of the overall NHS in England, which is 12.3%.[2]

The travel footprint is made up of three factors: patient travel at 31.1%, travel for staff to get to work at 30.3%, and staff travel for work purposes at 3.1%.[1] This paper will concentrate mostly on the patient and staff commuting travel as this amounts to 95% of dentistry-related travel. The suggestions to improve

travel within dentistry are equally applicable to commuting as they are to work travel.

Dentistry and its effect on air pollution

The air pollution impact of travel related to dentistry is also significant and equates to around 8% of the total NHS air pollution impact from travel.[3] The movement of staff and patients also affects air quality and, therefore, human health. The combustion of fossil fuels in vehicles, as well as from wear and tear, releases various air pollutants including nitrogen oxides and particulate matter. Nitrous oxides ($NO_{x)}$ are air pollutants released from the combustion of fuels in vehicles.[4] Particulate matter, generated from wear and tear from brakes, tyres and the road surface is classified as PM2.5 or PM10, depending on the size of the particles (that is, less than 2.5 or 10 micrometres). The smaller the particle, the further the particulate matter can penetrate into the lungs.[5] Both these pollutants impact on human health, such as asthma and chronic obstructive pulmonary disease (COPD) with one report estimating a potential impact of between 29,000 and 40,000 deaths in the UK.[6] Another method of measuring the impacts of health is using quality-adjusted life years (QALYs); a measure of the state of health of a person in which the benefits, in terms of length of life, are adjusted to reflect the quality of life. One QALY is equal to one year of life in perfect health.[7]

The entire NHS-related travel and transport (that is, staff commute, patient and visitor travel, business mileage, NHS fleet and from supplies and deliveries) contributes to around 3.5% of all road traffic in England. NHS-related travel creates a significant air pollution impact on the heath of the population which reduces an estimated 6,400 quality-adjusted life years (QALY) at a health cost of over £345 million per year. Better monitoring and measuring of travel impacts is needed, thus helping ensure organisations reduce the impact they have on air pollution and, ultimately, health to create a more holistically sustainable and healthy system.

The Sustainable Development Unit has developed the health outcomes of travel tool (HOTT) to help all NHS organisations measure the impact their travel has in environmental, financial and health terms. It allows the user to quantify impacts such as air and noise pollution, road traffic incidents and greenhouse gases from different travel sources.[8]

Table 1 Illustrating the effect of dental travel emissions on population health using the HOTT tool

	Staff business mileage by car	Patient travel	Staff commute	Total
Miles	41,261,174	476,471,033	241,134,752	758,866,959
QALY loss	19	195	111	325
Air pollution economic loss (£)	1,018,308	10,492,065	5,951,103	17,461,476
Tonnes nitrous oxide	21.52	224.90	125.74	372
Tonnes particulate matter (2.5)	1.20	11.01	7.03	19

In England, dentistry is responsible through its transport (around 760 million miles a year, 8% of all NHS related mileage) for reducing over 325 QALYs.[9] The impact of QALYs is because of the release of over 372 tonnes of NO_x and 19 tonnes of PM2.5 a year at a cost to health and society of £17.5 million. The health outcomes of travel tool (HOTT) can only quantify acute health impacts. In reality, the QALY impact is higher when factoring in additional travel emission-related morbidity such as increased aggravation of asthma symptoms (Table 1).[8]

To illustrate the effect of dental travel emissions on population health, staff commute and business mileage has all been calculated using an average car emissions factor for petrol and diesel vehicles, following the same method as the PHE dentistry carbon footprint modelling.[3] Patient travel has the same modal share as per the footprint modelling which is a mix of modes, including zero pollution active travel and lower pollution methods (per passenger), such as public transport.

Improving sustainable travel within dentistry

The dental team needs to consider innovative ways of reducing patient and staff travel. There are a number of ways this could be achieved.

Combining appointments

Combining family appointments could mean only one return car journey being necessary for a number of appointments and combining multiple procedures into one visit will reduce patient travel too. The scheduling of a dental examination with a hygienist to have a scale and polish and/or, where appropriate, the use of a one-stage scanning procedure for fixed prosthodontics are two examples that could also reduce travel.

Preventative dentistry

Sustainable dentistry goes hand-in-hand with preventive dentistry since reducing the need and, therefore, the number of treatments decreases the health and environmental impact. For people at higher risk of dental disease, providing preventive care will reduce the frequency or occurrence of dental disease and therefore reduce overall resource use in later years. National oral health programmes, such as the Scottish 'Childsmile' programme, also reduce travel carbon emissions and impact on air quality by providing outreach prevention for children.[10] Within the Childsmile programme, only the dental team needs to travel, rather than a number of individuals seeking similar preventive care at their dental practice.

Appropriate dental examination scheduling

Practitioners should consider the risk assessment approach to scheduling dental examinations. For patients at high risk of dental disease, dentists should see patients at three-monthly intervals and provide evidence-based prevention, as laid down by a number of evidence-based documents.[11,12,13] For patients who have low risk of dental disease, the maximum interval of 24 months for recall examinations should be implemented.[13] Reducing the frequency of examinations in an evidence-based manner will reduce travel associated carbon emissions and the impact on air quality.

Information technology

The number of physical dental appointments can also be reduced using advances in information technology. NHS England primary care (tier two) specialists in oral surgery can use information from electronic referrals, such as comprehensive medical history, clinical

photographs and radiographs to enable a patient to make only one appointment journey for their clinical procedure, rather than attend for a consultation and separately for a procedure. In the South-East of England and other areas, the dental electronic referral system (DERS) uses Google map technology which enables patients to choose the most appropriate specialist and their closest practice.[14] Where countries use a purchaser-provider split, such as England, commissioners of services can also have a significant influence over equitable provision and location of new dental services. GPS (global positioning system) technology can be used in needs assessments to support the delivery of accessible care and to optimise the amount of travel between a patient's home/work and care. This methodology was used , utilizing ArcGIS software, in an orthodontic needs assessment.[15,16]

Telemedicine has been used in many different healthcare areas with high satisfaction rates and, according to some studies, provides similar diagnostic comparability to traditional interventions.[17,18] Providing oral health visits via video conference would significantly reduce travel-related carbon emissions. Teledentistry was first implemented within the US army in the 1990s, allowing military dentists to consult with specialists at another location.[19] Although this approach may not be practical for all dental examinations, there are some early projects using this as a strategy. Within rural New York, a team of health workers, primary care and speciality care providers have utilised live video consultations, with a dental hygienist introducing the child to a dentist or specialist using an intraoral camera. The programme has reduced travel, clinical time and work time and also led to improved access to care and attendance.[20] However, the actual reduction may not be significant; as a study in Grampian, Scotland showed a reduction of only 0.1% in travel. A societal perspective is essential to calculate costs, and associated carbon emissions, of introducing teledentistry interventions which should include both patient and staff time as well as travel.[21] A recent article by Estai *et al.* provided a comprehensive review of the barriers and facilitators relating to the use of teledentistry.[22] More work, however, needs to be undertaken to establish an evidence base to support future teledentistry developments.

The use of teleconferencing has also the ability to reduce travel associated with attending meeting and conferences. Conferences such as the International Association for Medical Education (AMEE) now offer a live stream which will also reduce travel-associated emissions.[23] Dental conferences, therefore, should consider the applications of live streaming to their events.

Mode of travel

When considering sustainability, the mode of travel that staff and patients use is relevant, with the amount of carbon emissions and air pollution generated by each form of transport varying considerably. Active travel refers to travel that uses non-motorised methods to move between locations, the most common modes being cycling and walking.[24] This form of travel generates negligible carbon emissions. A journey by bus generates about 103 g of carbon dioxide equivalent emissions for every kilometre, a train generates 47 g per km, and a private car/taxi around 151 g.[25] These amounts vary because the emissions depend on the type of vehicle, the fuel used and, crucially, the number of people transported. The release of air pollutants follows the same relationship due to both the combustion of fuels and brake and tyre wear.[26] The impact of air pollution on health depends on where the pollutants are released; for example, a vehicle driving down a minor road will have a lower impact on health than a vehicle driving down a much busier road, due to the high population density.[27]

A conventional non-electric bus carrying one person is going to have a higher carbon footprint than a car carrying one person but the same bus at capacity will have a much lower footprint than a full car. Electric or hybrid buses will differ in their carbon footprint too. Interested readers should carefully appraise the methodology used to calculate carbon dioxide emissions, as there are a number of different methods but not all of them include the cradle-to-grave emissions of the vehicle; that is, the resources or carbon emissions it costs to produce and dispose of the vehicle as well as the fuel used to drive it for that specific journey. For this reason, a busy taxi would have a much lower carbon footprint per kilometre than a car which was seldom used.[28]

Active travel

The National Institute for Health and Care Excellence (NICE) recommends that employers have policies to encourage their employees to use active travel for their commute to work.[29] As well as being a more sustainable form of travel there are other significant benefits. There is significant evidence demonstrating the relationship between active travel and health outcomes.[30,31] The economic benefits of active travel are highlighted in a government document.[32]

Patients should be encouraged to walk or cycle. There are a number of ways staff can be incentivised to walk. For example, King's College, London, offered incentives such as pedometers and guided walks to staff.[33] People can also improve their health, save fuel, parking costs and reduce their carbon emissions by parking 10–15 minutes' walk away from the practice. Faster than walking, cycling is one of the most effective, healthy and environmentally friendly forms of travel, with low carbon emissions relating to the manufacture of the cycle and the 'fuel' used to power the cycle.[34] There are a number of studies showing the health benefits of cycling, with the added advantage of cycling reducing the amount of space required on roads.[35] The health outcomes of travel tool shows that a 5% shift to walking and cycling in staff commuting would reduce carbon and air pollutant emissions by over six tonnes of NO_x and 0.4 tonnes PM2.5, avoiding around £300k in costs to health and society. In addition, regular active travel has a health benefit to staff which could reduce societal costs by around £3 million a year.[2]

There are, however, barriers dental teams and staff may face cycling to the practice. From a staff perspective, staff need to be able to afford bicycles, have safe travel routes, know their bicycle is safe at work, and have access to appropriate changing and cleaning facilities.[36] There are ways that dental practices can support cycling for both their staff and patients. Many countries in Europe have subsidised cycling schemes.[37,38] Practices would need to consider how staff cycling to work can secure their bikes, store their cycle gear and shower. Practices could also consider providing maps of local safe cycle routes in staff induction packs, on practice websites and on patient noticeboards.[39] Another alternative, which might also reduce the need for showers within the surgery, is the use of an electric bike, which can make the commute easier and faster.

Public transport or car sharing

Patients and staff should be encouraged to lift share and use public transport. Practices could include public transport information on their practice websites, their practice notice boards and within their induction manuals. This would not only reduce travel-associated

Fig. 1 Action points to consider to improve the environmental sustainability of travel

		£		
Install secure cycle parking at the practice		££		
Provide showers, changing facilities and lockers where possible		£££		
Sign up to the Government's Cycle to Work Scheme and let staff know that it applies to e-bikes too		£		
Encourage and promote active travel options by sharing resources in the practice and on the practice website		£		
Display walking/cycling routes and maps of your local area in the practice		£		
Survey travel patterns of your staff and patients using an online survey tool (Such as Survey Monkeys) to find out how they currently travel and what could help them to incorporate more walking or cycling		£		
Combine patient appointments if appropriate to reduce overall travel		£		
Investigate the transport of goods and consider if it can be made more sustainable		£		
Always consider preventive dentistry		£		
Use information technology (e.g. Telemedicine and electronic referrals) to reduce staff and patient associated travel		££		
Implementation: Easy ... Less easy				
Investment costs: low £ ... high £££				
Financial return on investment (ROI) Low ... High				
Environmental benefit: Small ... Large				

carbon emissions, but would also reduce costs to staff and improve car parking availability.

The car sharing could be internal, between practice work colleagues, or it might be possible for staff to share a private car with people outside work travelling in the same direction. Using the website 'Liftshare' is one example of a site which provides linkages between people looking to do this.[40] For staff who travel infrequently, short-term rentals for business travel or commuting can be a cost-effective option. These rentals are more environmentally sustainable as the car would be used by a number of different people, thus cradle-to-grave carbon emissions associated with the production of the car could be divided by a number of users, rather than just one.

Electric vehicles

Electric vehicles (EVs) fuelled by electricity from renewable energy, not fossil fuels, can be an environmentally sustainable option. To ensure the lower carbon emissions associated with electric vehicles offset the carbon emissions associated with the construction of the car, consideration needs to be given to how frequently the car will be used.[41] The UK government is supporting a shift towards EVs.[42] Operationally, EVs have a much lower carbon and air pollution impact; if 25% of all dental-related travel was by EV, carbon emissions could be reduced significantly, avoiding over 68 tonnes of NO_x and 1.6 tonnes of PM2.5 a year and health impact costs by over £3.6 million a year.[2] Providing an electric vehicle charging point at the dental practice, with a set-up cost of around £300, could further promote the message of sustainability and encourage electric/hybrid vehicle usage.[43,44] Information relating to electric cars, in conjunction with maps of locally available charging points, could be included in practice information for patients.

Improving the sustainability of conventional car travel

Sometimes private car usage is unavoidable; particularly in areas where there are infrequent or unreliable alternatives. Car drivers should ensure they improve the sustainability of their vehicle by checking its tuning, its tyre pressure, ensures it weighs as little as possible by removing non-essential items, and driving sustainably. Engines should be switched off if paused and air conditioning used only when essential. Driving efficiency courses could be offered to practice staff; government organisations in the UK are already saving money with such schemes.[45]

Travel policies

Dental practices are encouraged to write travel policies. Within these policies, sustainability clauses can be included to reduce the organisational footprint and the impact of NHS travel on health due to air pollution. For example, staff could be incentivised to use only public transport for commuting and business travel, with higher carbon and air pollution-emitting business travel requiring specific approval. Larger dental practices might also consider writing a travel plan and guidance is available online on how to do this.[46]

Effective NHS travel plans can help improve access to dental care and delivery of services (for example, how outreach services are provided), support people in undertaking active travel and improve overall quality of life by reducing traffic congestion and improving air quality. The travel plan could consider ways of improving availability of information on travel modes and also look at changing current processes and systems within the dental practice. Staff, for instance, might be allowed to adjust their work patterns to arrive and leave ten minutes later to accommodate more sustainable ways of travel, such as public transport. Incentives could also be introduced to encourage more sustainable staff and patient travel. Some NHS Trusts have negotiated discounted bicycles through partnerships.[47]

Procurement-related travel

Although not factored directly into the NHS England dental carbon footprint (costs for transport of goods are given an average carbon factor), dental practices should consider the carbon emissions and the air pollution impact associated with the way they purchase goods.[1] Carbon emissions and air pollution impact will be reduced if the products come in the same delivery, transported from the same logistics centre, and ideally produced locally. Products, such as bananas, that are transported in bulk have surprisingly low travel-associated carbon emissions.[48] Products that are air freighted, or express-transported separately, have much higher footprints.[49] The dental team should also ensure that someone is always available to accept deliveries, thus avoiding the need for a repeat journey by the delivery company.

Laboratory-associated travel

From a dental laboratory perspective, the closest laboratory will have the lowest travel-associated carbon emissions and is therefore assumed to have a lower air pollution impact. A larger practice may be able to influence a dental laboratory to bulk-deliver their products. Dental practices may also be able to influence their laboratory to become more sustainable, perhaps utilising similar sustainable initiatives as discussed in this series of papers.[50,51,52,53,54,55] It may also be possible for a practice to reduce its overall travel-associated carbon footprint and air pollution impact by combining a staff member's commute with the laboratory drop off and/or pick up.

Evaluating change

In order to understand if the actions the dental practice has taken is having the desired effect of reducing carbon emissions and air pollution impact, the practice could consider undertaking an annual survey to calculate the distance, frequency and mode of staff and patient travel. Using this data in tools such as the health outcomes of travel tool will allow organisations to calculate their air pollution, carbon emissions, noise and the impact of accidents on human health.[3]

Action points

The action box (Fig. 1) provides some summary for readers to consider to improve the environmental sustainability of their travel. The reader should be advised that the judgement of ease, cost and impact is subjective, and more evidence is needed.

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