Commentary

Tackling Antibiotic Resistance: Why Dentistry Matters

Antibiotics are the cornerstone of modern medicine

Since Alexander Fleming's discovery of penicillin in 1928, antibiotics have become the cornerstone of modern medicine. Effective antibiotics are prerequisites for both preventive and curative measures, protecting patients from potentially fatal diseases and ensuring that procedures (such as major surgery and cancer chemotherapy) can be provided at low risk. As antibiotics become increasingly ineffective because of the development and spread of resistant infections, even minor surgeries and routine operations could become high-risk procedures.[1] Standard treatments for infections will also become ineffective, and infections will persist and spread more easily among populations.

Antibiotic resistance is such a risk to public health that it has been compared to the risk posed by climate change and global terrorism. With little prospect of new classes of antibiotics being developed, at least in the short term, a postantibiotic era is anticipated, in which effective antibiotics are no longer available.[1] The spread of resistant infections respects no borders, making this a complex global health problem that requires a global solution. Antibiotic resistance is a universal issue that could affect anyone; everyone is vulnerable.[2]

Guarding against a slow-motion pandemic, where the pace and spread of infections that do not respond to antibiotics increase globally, is vital. Clinical studies have shown that resistance occurring when a patient takes antibiotics persists in that patient's microbiome for up to 12 months.[3] Furthermore, these bacteria may develop resistance not only to the causative drug but also to several others. Exposing a patient to antibiotics when *not* necessary (eg, "just in case" or to meet patient demands) increases the risk that antibiotics will fail for that patient when they *are* necessary (eg, to treat sepsis). It also increases the risk that bacteria resistant to antibiotics will spread to the patient's families, friends, and other contacts. Before every decision to prescribe antibiotics, care must be taken to assess the risk of antibiotic resistance developing for the individual patient as well as spreading more widely across society. When people really need antibiotics, they really need them to work.

Is antibiotic resistance really a problem for dentistry?

Resistance is driven by the overuse of antibiotics in both people and animals (including for food production) as well as in the environment.[1] Patterns of resistance differ between places and over time. Dentists are responsible for about 10% of antibiotic prescribing for humans worldwide.[4] Despite efforts to reduce dental antibiotic use, too many antibiotics are still being prescribed by dentists. A study in the United Kingdom found that 80% of antibiotic use for treating acute dental conditions was unnecessary,[5] and a study in the United States found 80% of antibiotic use for prophylaxis was inappropriate.[6] The dental profession has a clear responsibility to commit and contribute to global, national, and local efforts to tackle antibiotic resistance.

Failure of antibiotics to treat effectively an infection in the mouth or elsewhere in the body (eg, respiratory tract infection), or to provide prophylaxis before major surgery (eg, joint replacement) can pose a life-threatening risk. For patients with dental infections, the spread of infection toward vital structures in the head and neck may occur rapidly. Optimising antibiotics use by prescribing in accordance with guidelines will result in improved outcomes for everyone, especially for the most vulnerable people. Dental infections are generally amenable to treatment by a dental procedure (such as extraction of the tooth) to remove the source of the infection without the need for antibiotics.[7] In the absence of infection, antibiotics are never appropriate for the pain such as that associated with irreversible pulpitis.[8] Dentists are surgeons, skilled and equipped to diagnose and treat acute dental conditions during urgent appointments; access to dental, rather than medical, care for patients with acute dental conditions is important. This growing problem of care provided in nondental settings (such as hospital emergency departments) contributes to overuse of antibiotics because the treatment provided is rarely definitive. Guidelines that are based on these principles while also considering other relevant factors (such as patterns of antibiotic resistance and access to high-quality antibiotics) sit at the heart of efforts to optimise antibiotic prescribing.

To assist efforts to reduce antibiotic resistance, the World Health Organization (WHO) has introduced 3 classifications of antibiotics: the AWaRe classification (access, watch, reserve).[9] The access group includes antibiotics that offer the best therapeutic value while minimising the potential for resistance. The watch group includes antibiotics that are more prone to selecting for resistance. Antibiotics in the watch group (such as erythromycin) should be the priority target for antibiotic stewardship programmes to optimise use. The reserve group includes the "last resort" antibiotics, such as meropenem, which are reserved for the treatment of infections because of multidrug-resistant organisms.

Antibiotics can be a risk to patient safety

Patient safety risks include adverse reactions to antibiotics. Allergy and anaphylaxis are well-known adverse reactions to antibiotics. Clindamycin is particularly recognised as being associated with significant rates of fatal and nonfatal adverse

drug reactions associated with *Clostridioides difficile* infections.[10] Antibiotic–related colitis caused by *C. difficile* is associated with significant morbidity and can be life-threatening, especially for patients who are elderly and/or medically compromised. Reports indicate that dental prescribing has contributed to the incidence of *C. difficile* in the community.[10]

The potential benefits of using antibiotics must be balanced against the risk of adverse outcomes such as severe allergy or anaphylaxis or antibiotic-related colitis or *C. difficile* infection and the risk of selection of resistance. Prescribing medication when there is no clinical basis for it is never in the patient's best interest and could amount to negligence. Clinical guidelines are designed to support clinical decision-making, and in following them, practitioners may help defend themselves against dentolegal claims.

What is the solution?

No one-size-fits-all solution exists. A variety of approaches is required to craft tailor-made solutions to respond to the locally relevant factors that drive unnecessary use of dental antibiotics. The FDI World Dental Federation[11] white paper provides a framework for dental teams to participate in global efforts to reduce antibiotic resistance.

Different contexts present different challenges, such as interpreting the evidence base underpinning guidelines for prophylactic indications, periodontal disease, and delayed prescribing for acute conditions. Furthermore, considerations important for treatment planning decisions in some low-middle-income countries, such as the widespread availability of substandard antibiotics for people to purchase in local shops, may not be relevant in some high-income countries. To assist those seeking to understand the factors driving unnecessary and inappropriate antibiotic prescribing in their context, the white paper offers a structure for analysis.[11] To help those seeking solutions to address these factors, the white paper includes an online library of resources from around the world that provides examples of material that may be adopted and adapted to meet local needs.[11]

Is there a global solution to a global problem?

The WHO Global Action Plan (GAP)[1] on antibiotic resistance aims "to ensure, for as long as possible, continuity of the ability to treat and prevent infectious diseases with effective and safe medicines that are quality-assured, used in a responsible way, and accessible to all who need them." Multisectoral national action plans (NAPs) are advocated to provide the basis for assessing national and regional priorities and the resources necessary to address them. With dentistry responsible for a significant proportion of antibiotic use worldwide, and with different factors influencing dental prescribers compared to medical providers,[12] it is important to ensure that dentistry is explicitly included within these NAPs. Furthermore, each national dental association should make a clear and public commitment to tackling antibiotic resistance through preventing infections, raising awareness, and optimising antibiotic use through effective stewardship (see Figure 1).

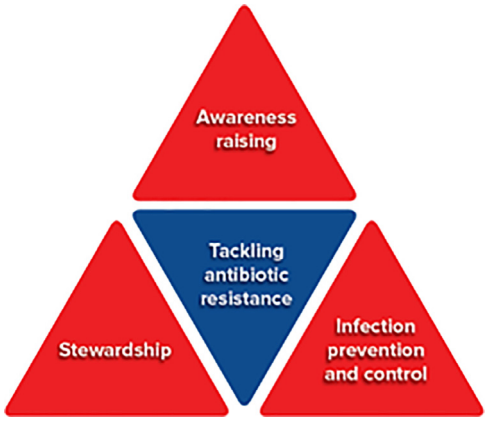

Fig. 1 – Opportunities for dental teams to contribute to global efforts to tackling antibiotic resistance. Reproduced by permission from the FDI World Dental Federation Antimicrobial Resistance Working Group.

Is there a national solution to the problem?

Tailoring national approaches to the specific context first requires a thorough analysis of the problem in that context. Many differences between countries exist in relation to antibiotic use and dentistry, foremost among which is whether therapeutic or prophylactic use contributes most to the burden of unnecessary and inappropriate prescribing. Furthermore, the prevalence of substandard and counterfeit drugs is a problem in many low- and middle-income countries, together with the availability of antibiotics for purchase over the counter from grocery stores and street vendors.[12]

FDI has committed to support the development of NAPs to tackle antibiotic resistance by the dental professional.[11] In some cases, significant investment and resources may be required to develop and implement a NAP that is fit for the local context, rather than based on research and data from other countries. The development of guidelines that are based on this national context, including antibiotic-resistance patterns, is essential and should be done in multidisciplinary collaboration with pharmacists and microbiology and infectious disease specialists.

What is the role of antibiotic stewardship?

Some consider antibiotic stewardship to be the core of efforts to tackle antibiotic resistance by optimising the use of antibiotics.[10] Stewardship is, however, only one of the strands identified by the WHO Global Action Plan.[1] Awareness raising of the problem is also important to communicate the concept of resistance to professional and nonprofessional audiences. Personalising the agenda to introduce a sense of jeopardy for individuals by focusing on antibiotic resistance as a problem that affects everyone has been identified by international research as key for behaviour change.[2] Dental professionals are highly skilled communicators who are well-placed to deliver these public health messages. Members of the dental team hold a high degree of respect within local communities, and there is a responsibility to use this privileged position to

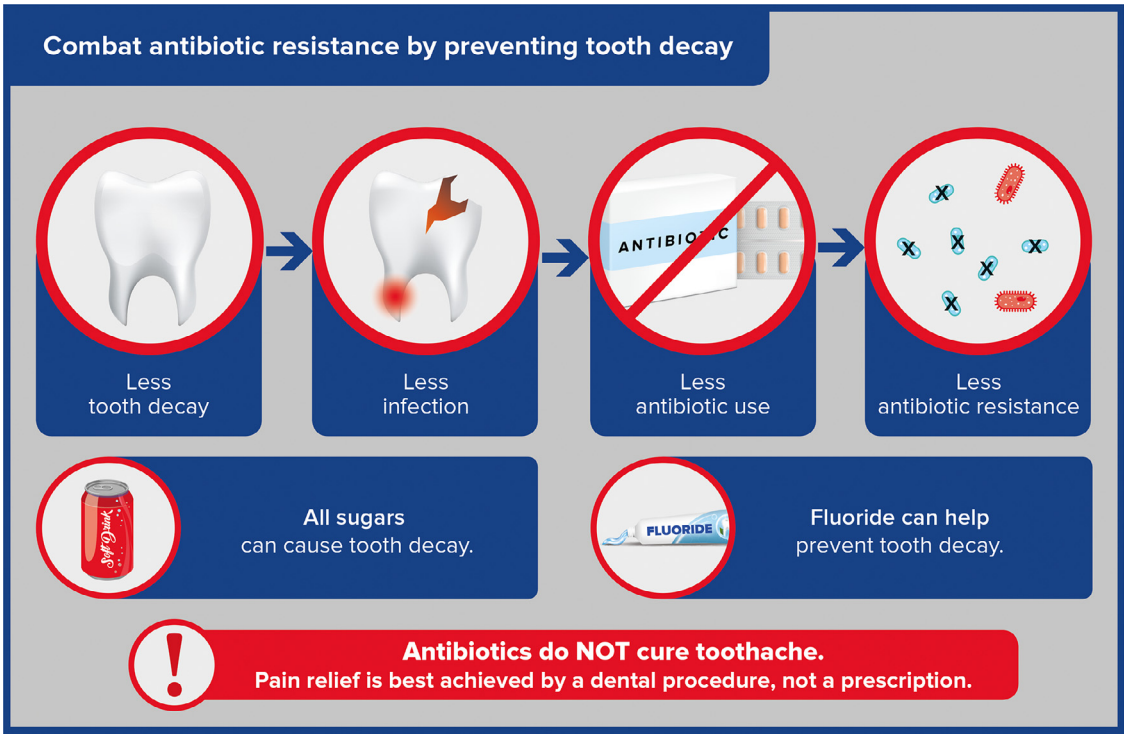

Fig. 2 – Dietary advice and rewarding excellence in oral hygiene are important ways of preventing dental caries.

raise awareness about antibiotic resistance among the general population, as well as with patients.

Preventing infections is the third element of dental teams' contribution to tackling antibiotic resistance. Preventing the development of dental infections by advocating for reduced sugar consumption (including through sugar taxes)[13] and fluoridation programmes[14] is an important contribution that dental public health can make to the global fight against antibiotic resistance. Within the dental surgery, dietary advice and rewarding excellence in oral hygiene are important ways of preventing dental caries (see Figure 2) and periodontal disease, which in turn reduce the risk of dental infections. Early diagnosis and treatment of dental disease are also important ways in which dental teams contribute to preventing infections and reducing the need for antibiotics.

The discipline of "infection prevention and control" occupies a unique position in the field of patient safety and quality universal health coverage because it is relevant to health care workers and patients at every single health care encounter. Within dentistry, examples include hand hygiene, personal protective equipment, sterilisation of equipment, and sharps handling.

The importance of designing tailor-made solutions

When designing solutions to tackle antibiotic resistance, the first step is to understand what factors are important in the local setting. General dental practices may need different solutions to hospital-based or domiciliary care teams (eg, in nursing homes). Those working in secure settings (eg, in prisons or detention centres) have different needs to those working with people who are homeless, refugees, asylum seekers, or who are working in remote parts of the world.

Research based on behavioural theory has shown that the decision to prescribe dental antibiotics is multifaceted and sensitive to context.[15] Solutions to address these factors must similarly be multifaceted and tailored to local needs rather than taking a one-size-fits-all approach. Understanding the problem in the specific context is essential to customise local solutions. For example, if analysis of the problem in a given area shows that dentists' beliefs about their ability to provide operative procedures during unscheduled appointments has a significant impact on their decisions to prescribe antibiotics, interventions should focus on supporting dentists to provide dental procedures for patients with acute conditions (such as extractions and treating pulpal disease). If the problem of overprescribing is related to dentistry being treated as a commercial activity, the solutions need to include ways to address factors such as remuneration models that mean "time is money" and make "quick fixes" that are highly valued by dental teams. Notably, non-clinical members of the dental team, such as the practice or clinic manager, may have important roles to play in relation to antibiotic stewardship. Thus, exploration of the wider factors that influence the decision to prescribe antibiotics in a specific setting is essential to the development of a locally relevant approach to tackling antibiotic resistance by the whole dental team.

This is a rapidly evolving agenda and a range of interventions have been reported in the academic literature, including education, dissemination of guidelines, and audit and feedback. Dental resources from around the world are provided in

the FDI white paper's online library for local adoption or adaptation by those designing and implementing approaches to tackle antibiotic resistance.

Conclusion

Antibiotics are essential to modern medicine and can be life-saving drugs. Everyone is vulnerable to antibiotic resistance and everyone has a role in tackling it. Minimising resistance and ensuring the judicious use of antibiotics is the joint responsibility of everyone working in the health care sector. The risks of antibiotic use for patients need to be balanced against its benefits. Antibiotic resistance is just one of the risks. Understanding and being able to explain the risks of antibiotics (as well as the benefits) is an important part of consenting patients to treatment.

There is no one-size-fits-all solution to tackling antibiotic resistance as factors influencing it are so different between places and over time. By preventing dental infections, raising awareness about antibiotic resistance, and optimising the use of antibiotics through stewardship, the dental profession can protect individual patients and society more generally. Local solutions are required to address the global problem of antibiotic resistance. When dentists and patients share decisions about whether to prescribe an antibiotic, the factors to consider in low- and middle-income countries may be quite different to the priorities elsewhere. By helping people prevent dental infections, the dental team has an important role to play. The dental profession's role in tackling antibiotic resistance is further defined in FDI's white paper (including its online library of resources from around the world) and in a massive open online course developed in collaboration with the British Society for Antimicrobial Chemotherapy. These resources are aimed at any individual who aims to safeguard the effectiveness of antibiotics for future generations.

REFERENCES

1. World Health Organization (WHO). Global action plan on antimicrobial resistance. Geneva, Switzerland: WHO; 2015.
2. Wellcome Trust. Reframing resistance - How to communicate about antimicrobial resistance effectively. London, UK: Wellcome; 2019.
3. Costelloe C, Metcalfe C, Lovering A, Mant D, Hay AD. Effect of antibiotic prescribing in primary care on antimicrobial resistance in individual patients: systematic review and meta-analysis. Br Med J 2010;340:c2096.
4. Shah S, Wordley V, Thompson W. How did COVID-19 impact on dental antibiotic prescribing across England? Br Dent J 2020;229:601–4. doi: 10.1038/s41415-020-2336-6.
5. Cope AL, Francis NA, Wood F, Chestnutt IG. Antibiotic prescribing in UK general dental practice: a cross-sectional study. Community Dent Oral Epidemiol 2016;44(2):145–53.
6. Suda K, Calip G, Zhou J, et al. Assessment of the appropriateness of antibiotic prescriptions for infection prophylaxis before dental procedures, 2011 to 2015. JAMA Netw Open 2019;2(5):e193909.
7. Cope A, Francis N, Wood F, Chestnutt I. Systemic antibiotics for symptomatic apical periodontitis and acute apical abscess in adults. Cochrane Database Syst Rev 2018;9(9):CD010136.
8. Agnihotry A, Thompson W, Fedorowicz Z, van Zuuren EJ, Sprakel J. Antibiotic use for irreversible pulpitis. Cochrane Database Syst Rev 2019;5(5):CD004969.
9. World Health Organization (WHO). WHO antibiotic categorization. Accessed from: https://aware.essentialmeds.org/groups. Accessed 29 October 2020.
10. Teoh L, Thompson W, Suda K. Antimicrobial stewardship in dental practice. J Am Dent Assoc 2020;151(8):589–95.
11. Thompson W, Williams D, Pulcini C, Sanderson S, Calfon P, Verma M. The essential role of the dental team in reducing antibiotic resistance, 74. Geneva, Switzerland: FDI World Dental Federation; 2020. p. 2139–52.
12. Thompson W, Douglas G, Pavitt S, Sandoe J, McEachan R, Tonkin-Crine S. Factors associated with prescribing of systemic antibacterial drugs to adult patients in urgent primary health care, especially dentistry. J Antimicrob Chemother 2019;74(8):2139–52.
13. FDI World Dental Federation. Sugars and dental caries. Geneva, Switzerland: FDI World Dental Federation; 2016.
14. FDI World Dental Federation. Promoting oral health through water fluoridation. Geneva, Switzerland: FDI World Dental Federation; 2014.
15. Thompson W, McEachan R, Pavitt S, Douglas G, Bowman M, Sandoe J. Clinician and patient factors influencing treatment decisions: ethnographic study of antibiotic prescribing and operative procedures in out-of-hours and general dental practices. Antibiotic 2020;9(9):575.

Wendy Thompson *
David Williams
Céline Pulcini
Susie Sanderson
Philippe Calfon
Mahesh Verma

Division of Dentistry, University of Manchester, Manchester, UK
Institute of Dentistry, Queen Mary University of London, London, UK
Université de Lorraine, APEMAC, Nancy, France
British Dental Association, London, UK
Association dentaire française, Paris, France
Vice Chancellor, Guru Gobind Singh Indraprastha University, Delhi, India

**Corresponding author*. Division of Dentistry, University of Manchester, Couplands 3, Oxford Road, Manchester, M13 9PL.

https://doi.org/10.1016/j.identj.2020.12.023