Antibiotic resistance and how to act on it

Bacteria becoming resistant to antibiotics is a natural phenomenon but is made worse by suboptimal and unnecessary use of antibiotics. Changes to dental prescribing practices and patient education are needed to resist this problem

The emergence of antibiotic-resistant bacterial colonies represents a significant threat to worldwide public health. A recent Department of Health statement concluded: 'There are few public health issues of greater importance than antimicrobial resistance in terms of impact on society. This problem is not restricted to the UK. It concerns the entire world and requires action at local, national and global level' (Department of Health, 2013).

Dental professionals should be aware of the issue of antibiotic resistance. They can play an important role in stemming the tide of the problem.

The emergence of antibiotic resistance

Since their introduction in the 1940s, antibiotics have saved millions of lives, curing bacterial infections that would have previously proved fatal. However, soon after their earliest trials, it became evident that some bacteria were naturally resistant to these agents. Alexander Fleming warned: 'The time may come when penicillin can be bought by anyone in the shops. Then there is the danger that the ignorant man may easily underdose himself and by exposing his microbes to non-lethal quantities of the drug make them resistant' (Fleming, 1945).

Antibiotic resistance is frequently divided into two forms: intrinsic and acquired. In intrinsic or natural resistance, bacteria do not allow the drug to penetrate through their cell wall or do not contain the target chemical the antibiotic acts upon. With acquired resistance, normally susceptible bacteria change their physical or genetic format and acquire new enzymes or proteins that provide a defence against the drug (*Box 1* and *Figure 1*). The genes responsible for these changes are usually located on the plasmid, a small circular form of DNA that can transfer from one bacterium to another, facilitating the spread of resistance between different types of bacteria (Byarugaba, 2010).

Acquired resistance is of particular concern to scientists investigating antibiotic resistance. The significance

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Box 1. How bacteria become resistant to antibiotics

- New or modified enzymes in the bacteria, e.g. beta-lactamases, degrade the antimicrobial agent
- A mutation in the antibiotic's target chemical reduces the binding ability of the antibiotic agent
- Uptake of the antimicrobial agent is reduced through changes to the bacterial cell wall
- Bacteria increase their capacity to remove the antibiotic by efflux

Box 2. Medical factors increasing the likelihood of antibiotic resistance

- Suboptimal use of antimicrobials for prophylaxis and treatment of infection
- Noncompliance with infection-control practices
- Prolonged hospitalisation
- Increased number and duration of stays in intensive care units
- Multiple comorbidities in hospitalised patients
- Ineffective infection-control practices
- Transfer of colonised patients between hospitals
- Grouping of colonised patients in long-term care facilities, e.g. residential homes
- Antibiotics in agriculture and household cleaning products

of increasing antibiotic resistance is that infections that were previously easily treated with antibiotics are becoming harder and harder to manage. This is compounded by the decline in the research and development of new antibiotics.

The medical factors that contribute to antibiotic resistance are summarised *Box 2*. One of the most significant factors is the overuse of antibiotics in primary care. Reducing antibiotic dispensing at general practice level has been associated with a reduction in local antibiotic resistance (Butler et al, 2007).

Antibiotic-resistant bacteria are being increasingly isolated from acute dental abscesses (Kuriyama et al, 2006) and studies have identified a correlation between the emergence of antibiotic-resistant bacteria with previous administration of antibiotics in dental infections (Kuriyama et al, 2000).

Clinical audit has demonstrated the presence of penicillin-resistant bacteria does not adversely affect clinical outcomes if local measures are carried out (Kuriyama et al, 2005).

In addition, it should be remembered that the prescription of systemic antibiotics for dental problems does not apply a selective pressure only to oral bacteria; the overuse of penicillins in the treatment of dental conditions could potentially affect the prevalence of antibiotic-resistant colonies implicated in the aetiology of pneumonia, bacterial meningitis and upper respiratory tract infections.

Antibiotic use in dentistry

Dental practitioners are responsible for approximately 9% of all community antibiotic prescriptions in England and Wales (Karki et al, 2011; Health and Social Care Information Centre, 2013). The vast majority of these antibiotics are penicillins (amoxicillin, penicillin V and co-amoxiclav) or metronidazole; there are often wide variations in the dose, frequency and duration of course prescribed by dentists (Palmer et al, 2000).

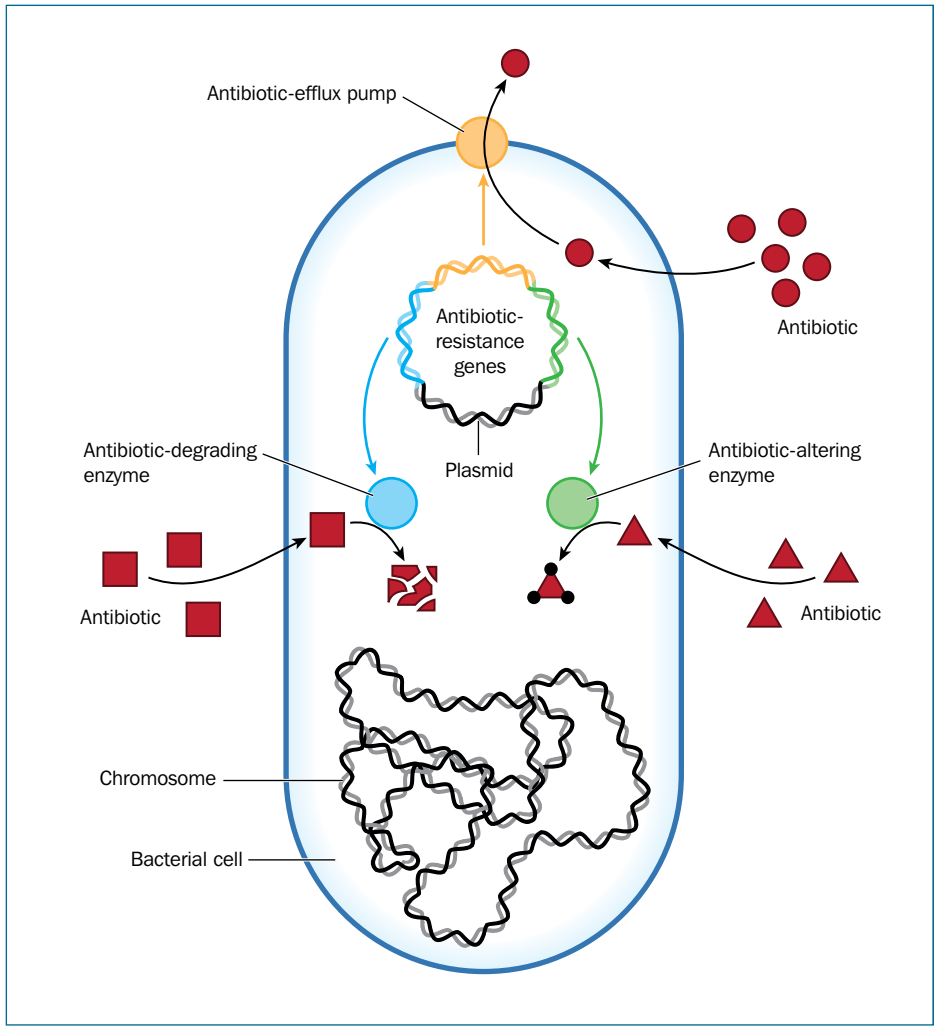

Figure 1. Mechanisms of antibiotic resistance in bacteria

Within dentistry, large numbers of antibiotics are prescribed for acute dental conditions such as symptomatic apical periodontitis and abscesses. However, clinical guidelines recommend that the first-line treatment of these conditions should be primarily based on local measures, such as dental extraction, pulpal extirpation or incision and drainage of a swelling, and that antibiotics are not indicated in the management of odontogenic infections in the absence of spreading infection and systemic upset in healthy patients (Scottish Dental Clinical Effectiveness Programme, 2011).

This is because the majority of acute dental conditions, such as pulpitis, are inflammatory not infective in nature. A Cochrane systematic review concluded that there was no significant difference in patient-reported pain between groups of patients with irreversible pulpitis who were treated with either an antibiotic or a placebo (Keenan, 2005).

Despite this, there is evidence that antibiotics are being routinely prescribed to patients with acute dental conditions (such as pulpitis and alveolar osteitis, also known as dry socket) where they are likely to be of little clinical benefit. In a retrospective analysis of clinical records from an out-of-hours dental clinic in the Merseyside, investigators reported that more than 50% of patients received antibiotics alone with no other definitive treatment provided. Antibiotics were often provided for conditions such as apical periodontitis and alveolar osteitis, which can be managed effectively by local

KEY POINTS

- Dentists prescribe nearly one out of every ten antibiotics dispensed in the community in England and Wales.
- Inappropriate antibiotic prescribing is considered a key cause of antibiotic resistance.
- Antibiotics should be prescribed for dental infections only where there is evidence of spreading infection or systemic involvement and only in conjunction with a local measure, such as extraction or endodontic treatment.
- Inappropriate prescribing in dentistry may be associated with time and workload pressures and patient expectations of receiving an antibiotic.

measures (Tulip and Palmer, 2008).

Other studies suggest that antibiotics are being used as a substitute for local measures in emergency appointments (Dailey and Martin, 2001). This inappropriate use of antibiotics, in addition to intensifying resistance, wastes resources, exposes patients to potentially serious side effects and encourages patient expectations of antibiotics for dental problems in the future (Butler et al, 2012).

Inappropriate prescribing

Relatively little is known about why dentists prescribe antibiotics where they are not recommended by clinical guidelines. However, time or workload pressures (e.g. when emergency appointments are double booked in addition to existing patient appointments) and uncertainty around diagnosis may have significant effects on the prescribing behaviours of dentists (Palmer et al, 2000).

Furthermore, it is likely that some inappropriate prescribing may occur in response to patient expectations or requests for antibiotics. Despite intensive media coverage of pathogens such as MRSA and *Clostridium difficile*, many patients still feel let down if they do not get a prescription for antibiotics for an infection, irrespective of the seriousness or potential duration (Costelloe et al, 2012). Patients not only pressurise their dentist for an antibiotic prescription but also self-medicate with antibiotics, particularly in eastern and southern parts of Europe and in some developing countries (Grigoryan et al, 2006).

Improved education

Education is key to improving patients' satisfaction and willingness to accept local measures as their only treatment, rather than get a prescription for antibiotics for an acute dental condition. Encouragingly, evidence suggests that only 3% of patients who expect but do not receive an antibiotic for a dental problem are dissatisfied with their dentist's decision (Seager et al, 2006). Good communication on the relative benefits and risks of both operative and pharmacological treatment options will often reduce a patient's expectations of antibiotics.

Interventions are also required to optimise antibiotic prescribing among dental professionals. In the past, clinical audit and pharmacist-led educational courses have improved prescribing behaviour (Palmer et al, 2001; Seager et al, 2006). However, it is often unclear whether practitioners maintain this improvement in the long term.

Length of course

A prescription for antibiotics is necessary for certain odontogenic infections, especially if there are signs of spreading infection or systemic involvement. In these cases, patients are generally prescribed a course of antibiotics of five to seven days in duration (Palmer et al, 2000).

However, this advice may be frequently inappropriate as the duration of antibiotic therapy in most patients with acute dentoalveolar infections can safely be two to three days, provided that drainage has been carried out (Martin et al, 1997). In a recent audit conducted at Bristol Dental Hospital, following drainage and removal of the source of infection, a three-day standard dose antibiotic regimen was effective in the management of acute apical abscesses in all reviewed patients showing associated signs of systemic symptoms (Ellison et al, 2011).

Conclusions

The resistance of pathogenic bacteria is a natural phenomenon but is made worse by frequent human exposure to suboptimal and unnecessary antibiotics. If prescribing practices remain unchanged, strains of bacteria will continue to emerge.

Given the limited number of new antibiotics becoming available, we risk returning to the pre-antibiotic age when relatively common infections will once again be fatal.

Dental care professionals should therefore always attempt local, operative

'Antibiotics are being routinely prescribed for acute dental conditions where they are likely to be of little clinical benefit'

measures when faced with odontogenic infections (Cope et al, 2013) and only prescribe antibiotics in situations of spreading infection or systemic involvement. DN

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