DENTAL MEDICINE

A survey of dental professionals' opinions around the use of antibiotics in molar 3 extractions and dental implant placement

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Abstract

Aim. This survey was conducted to determine the type and frequency of antibiotics (AB) use for the prevention of infections in dental third molar (M3) extraction and implantation procedures (DIP) among UK dentists and the opinions underpinning their practice.

Methods and design. Systematic reviews of the evidence were undertaken alongside this survey of practicing dentists in the United Kingdom to identify the opinions and practices of those undertaking the procedures.
With ethical approval, a survey was designed for online delivery and was sent to every dental practitioner in the UK with a publicly available email address or social media contact. The opening page provided the project information sheet and proceeding to complete and submit the questionnaire was considered consent to participate. The online survey was circulated to 900 identified addresses and a total of 145 responses were received. Responses were collated in Microsoft® Excel™ and analyzed using IBM® SPSS™ plus thematic analysis of free text responses.

Results. There were 42% of participants (n=61) who discouraged AB prophylactic use in M3 extractions in people with no systemic conditions and who also preferred postoperative AB use when required. Where, 57.9% of respondents (n=84) supported the short-term use of ABs (5-7 days) for M3 extraction and 53% (n=77) in DIP placement in patients with no relevant medical history. As an *ad hoc* finding, dentists reported on the negative impact of heavy smoking and oral parafunctional behavior on DIP success.

Conclusion. The use of antibiotics and broad spectrum antibiotics remains higher than current guidelines would recommend. Further research is required to clarify the specific risks arising from underlying medical conditions to further clarify where prophylaxis is required.

Keywords: third molar extraction, wisdom teeth extraction, dental extractions, dental implant placements

DOI: 10.15386/mpr-2634

Manuscript received: 17.04.2023
Received in revised form: 21.06.2023
Accepted: 03.07.2023

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Introduction

Invasive dental procedures carry a risk of localized post-operative infections, and, particularly for certain high risk individuals, systemic infection. There are three major pathways that link oral infection to secondary systematic diseases; metastatic spread of infection from the oral cavity due to transient bacteremia, metastatic injury due to circulating oral microbial toxins, and metastatic inflammation due to immunological injury induced by oral microorganisms [1].

In a healthy individual, brief transient bacteremia rarely results in systemic infection. Poor oral health has a significant impact on general health as it may disrupt speech, nutritional intake, appearance and self-esteem. It also can result in pain, halitosis and discomfort [2]. It may lead to dental caries and periodontal diseases; the National Dental Epidemiology

Programme oral health survey 2018 [3], looking at adults attending general dental practices in England, found 27% had untreated tooth decay with a mean of 2.1 decayed teeth, and 53% had gingival bleeding.

The United Kingdom (UK) National Institute for Health and Care Excellence (NICE) clinical guidelines discourage routine prophylactic antibiotic use, recommending only in patients with systemic conditions e.g., recent prosthetic joint replacement, cardiac valvular incompetency [4], including in their 2015 update. Underlying cardiac conditions are considered an elevated risk for bacteremia, during invasive dental treatments [5, 6], including procedures involving manipulation of the gingival tissue, the periapical region of teeth, or perforation of the oral mucosa. However, NICE CG64 [4] does not recommend antibiotic prophylaxis in the absence of pre-procedure infection.

Antimicrobial Resistance (AMR) has been attributed to over-, under-use and misuse of antimicrobials, allowing resistant organisms to proliferate through natural selection, and for transfer of resistance genes across species. According to 2010–2017 data from the UK Faculty of General Dental Practitioners (FGDP), dentists working in primary care in England prescribed almost 10% of all oral antimicrobials used in England [7] with 80% of the antibiotic prescribing subsequently considered by reviewers to be unnecessary [8].

A 2020 World Dental Federation policy statement, aimed to promote responsible use of antibiotics and tackle resistance at local and national levels [9]. In line with antimicrobial stewardship principles, to treat an infection that is not life-threatening, narrow spectrum antimicrobials should be used. The FGDP guidelines recommend the shortest effective course of the right drug and dose only when there is a genuine clinical indication of bacterial infection. The UK College of General Dentistry provides three guidance documents; 'Antimicrobial Prescribing in Dentistry' 3rd Edition (2020) [10], aims to provide professionals with practical, straightforward guidance on when antimicrobials should be prescribed, at what dosage, and for what duration. The Antimicrobial Prescribing Self-Audit Tool, published by the British Dental Association (BDA) [11] aims to assist dental prescribers to audit their prescribing of antimicrobials in infection management, and to compare their practice with published guidance. They also provide the Dental Antimicrobial Stewardship Toolkit [12].

Insufficient evidence exists for specific AB dosage, or whether short or longer AB treatment protocols are required to prevent early implant failures. To address this, two systematic reviews and meta-analyses were undertaken on antibiotic use in molar 3 tooth extraction procedures [13], and on dental implant placements [14].

This survey was conducted to determine the type and frequency of AB use for the prevention of infections in dental extraction and implantation procedures among UK dentists from different specialties, different practice settings, and the opinions underpinning their practice.

The survey explored opinions and practices on:

1. The best AB for M3s extraction and placement of DIP.
2. The efficacy of AB for reduction of postoperative infection complications in M3s extraction and placement of DIP.
3. The confounding factors responsible for postoperative complications of M3s extraction and placement of DIP.

Methods and design

The survey was approved by Life Sciences Ethics Committee (LSEC) at the University of Wolverhampton on 13/04/22 with the registration number: LSEC/202021/HM/9.

An online questionnaire was developed to be distributed to UK general dentists, oral surgeons and oral maxillary surgeons from secondary care, primary care and academic practice. The survey comprised of 26 questions, a mixture of multiple-choice questions, multiple response questions and open text comments when the respondent selected the 'others' option. The first part collected demographic and general information including (gender, location of training, workplace (health sector or academic), years in practice and specialization. In the second and third sections, information about choices of prescribing ABs in M3s extractions and DIP placements (type, strength, duration and frequency) and co-prescribing of mouthwash for oral hygiene and analgesics for pain management for their healthy adult patients (no comorbidities), who are not allergic or allergic to penicillin. The remaining questions sought information on knowledge of the AB effectiveness, confounding factors related to postoperative complications of teeth extractions and DIP failures due to infections. The questionnaire was reviewed by three practicing dentists to ensure it covered profession-specific matters at an appropriate level.

Previous UK dental surveys showed response rates from 17=90% [15] of the reachable sample. On advice from the BDA and the General Dental Council (GDC) the researcher was advised to approach dentists and dental specialists on individual basis using the Local Dental Networks and publicly advertised emails and social media tags. Using this approach 300 email addresses were identified, plus 600 dental professionals on social media platforms resulting in a total sample of 900 who were approached. Using this as the reachable population size, the target sample was calculated as 260 dental professionals required to produce a confidence level of 95% and a 5% margin of error.

Any UK dental practitioner holding GDC registration, or on the GDC specialists list were included. Trainees who had completed most of their training and are allowed to perform a minimum of dental extraction were also invited. Additionally, participants were required to be involved in the direct management of patients who needed dental extractions or DIP placements.

The distribution of the online survey commenced at midnight 27/04/2022 and closed at 11.59 on 31/07/2022. The online version of the questionnaire was loaded onto the Joint Information Systems Committee (JISC) Online© (Bristol, UK) survey software application. A hyperlink™ that could be used on any internet access device was circulated. The study information sheet was the first page, to be read before the survey could be accessed. Only participants who selected 'Yes, proceed' gained access to the survey questions, so submission of the questionnaire was deemed to be consented to participate. The respondents were assured that their participation was entirely voluntary and anonymous. The survey took around 20 minutes to complete.

All data collected were entered onto Microsoft® Excel™ (Microsoft Corp, Redmont WA, USA) version 16.63.1, 2022 and imported into IBM® SPSS™ version 28.0.0.0(190) (IBM Armonk, NY, USA) for analysis. During data cleaning and verification, the place for current practice by cities (Question 4), was recategorized by country (England, Scotland, Wales or Northern Ireland). Additionally, spelling for ABs was also standardized to UK spelling (Questions 10, 11, 19 & 20). Also, the medical terminology used to describe complications due to infection was standardized (Questions 13 & 23). Two questions (15 & 25) had multiple responses, where respondents were requested to mark all responses applicable to their practice, those questions were analyzed using SPSS™ complex sample analysis. Demographic characteristics of respondents was reported by frequency and percentage. Regression analysis was conducted where possible.

Results

Demographic characteristics

A total of 145 responses were received by end of July 2022. Example free text comments are shown below each section. Unless otherwise stated each was an individual comment. The general characteristics are summarized in table I. This also broadly reflects the overall profile of UK dental professionals [15].

AB Prescribing in M3 extractions

Q 6 (Do you prescribe ABs for surgical extraction of M3 for a healthy adult patient?) and Q7 (If 'yes', when do you usually prescribe AB?) received 143 responses. In total, 61 (42%) responded 'never,' 52 (36%) responded 'rarely,' 25 (17%) 'sometimes' and 5 (3%) 'always.' 7% (n=10) selected 'other' option. Three themes were identified: 1) High risk patient due to pre-existing medical conditions (n=4, 40%), 2) Infection due to M3s extraction procedures e.g., unsterile, long or difficult (n=6, 60%) and 3) High risk patient due to pre-existing infection (n=3, 30%).

"Only if medically compromised/immunosuppressed."
"I use oral ABs for local anaesthesia (LA) procedures if the surgery is prolonged or complicated. If the procedure is under general anaesthesia (GA), then almost all patients will receive induction ABs. Very occasionally, oral ABs to take home are prescribed depending upon the complexity."
"Infection is clear and that depends on initial risks and also the trauma intra operative, and difficulty of the extraction."
"Rare: cardiology related - depending on advice of cardiologist." "Only prescribed if patient presents post op with trismus, with alveolar osteitis."
"Only if there was an abscess or if it was a complicated extraction."
"I only prescribe if infection is imminent."
"Several heart condition and only when physician has prescribed it" and "Only if systemic symptoms of infection (fever, lymph nodes) are present."
"Given if infective osteitis and no local measures effective."
"ABs are not indicated for M3 extractions."

The British National Formulary [17] recommends broad-spectrum penicillin group ABs (e.g., amoxicillin 500 mg every 8 hours), if no allergies or intolerances. For patients with penicillin allergy metronidazole 400 mg every 8 hours [17] is the recommended alternative. Participants were then asked which AB they prescribe most often for M3s extraction, for an adult patient with no penicillin allergy, only 79 (54.5%) of dentists responded. Amoxicillin was most frequently prescribed (77, 53.1%) followed by phenoxymethylpenicillin (9, 6.2%), co-amoxiclav (8, 5.5%), metronidazole (8, 5.5%). For penicillin allergic patients respondents' first-choice AB was metronidazole 69 (47.6%), followed by clindamycin 11 (8%) and erythromycin 11 (8%).

Table I. Summary of participant characteristics.

Gender	94 (65%, male)	48 (33%, female)	3 (2%, prefer not to say)			
Years in practice	>20 year 40 (28%)	15-20 year 22 (15%)	11-14 year 25 (17%)	6-10 year 30 (21%)	≤5 year 28 (19%)	
Practice setting	105 (72%, private practice)	34 (23% NHS practice)	28 (19%, NHS hospital)	11 (8%, oral Surgery)	3 (2%, community)	9 (6%, academics)
Specialty	86 (59%, general dental)	12 (8%, oral, maxillofacial surgeons)	13 (9%, oral surgeon)	33 (23%, special interests)	1 (<1%, aesthetic dentistry)	
Practice location	121 (83%, England)	8 (5%, Northern Ireland)	6 (4%, Scotland)	10 (7%, Wales)		

When asked if they usually prescribe ABs in dental extraction procedures, 61 (42.1%) prescribe ABs following M3 extractions, 10 (6.9%) prescribed ABs before and after surgery and 7 (4.8%) indicated that they prescribe ABs prior to M3s procedures in non-medically compromised patients.

"Not all M3 removals require ABs. I would reserve them due cases where there is significant survival intervention i.e. flap raised, bone removal and tooth division."
"For M3 removals I would prescribe ABs postoperative if the removal took more than 25 minutes, or if they are a heavy smoker, or diabetic, or if there was suppuration in the extraction site at time of surgery."
"Only in immunosuppressed individuals."
"If they return with infection postoperatively."
"Before only for certain medical indications e.g., cardiac."
"Postoperative GA 1 x IV at induction LA bone removal 5-days Abs otherwise nil."

On oral hygiene advice following M3s extractions (use of mouthwash or saline before or/and after procedures), 141 participants answered this question, 33 (22.8%) participants reported that they do not advise mouthwash or saline, 65 (44.8%) reported that they advise postoperative use, 24 (16.6%) reported that they recommend those products before and after surgery and 13 (9.0%) only before.

"Very rarely pre-extraction with chlorhexidine mouthwash if at risk of poor healing."
"Only for a few days after the surgery, depending on extraction."
"Before and after extraction for 24 hours."
"24 hours after extractions with saline."
"After surgery commencing 24 hours."
"Chlorhexidine preoperative and saline postoperative."
"Use of pre-operative mouthwash has been curtailed due to COVID."

For the 'how long do you recommend AB be used for M3 extraction? question, the prescribing recommendation of the BNF is 'use should be limited to short, or as required, courses' [14]. The most recommended duration was 5-7 days (84, 57.9%) or 3-4 days (11, 7.6%).

"Induction only before GA; If LA, I may prescribe oral ABs if procedure was long or complicated."
"Oral for 7 days - 21 tabs 8 hourly."
"Oral for 3-5 days."
"Oral, single dose."
"One dose intravenously for GA otherwise orally for 5 days LA."

The following question was 'how often do ABs fail to prevent infection following M3s extractions?' There were 56 (38.6%) were unsure, 31 (21.4%) believed they rarely prevent infection, 7 (4.8%) believed they never failed to prevent infection in M3s extractions, 14 (9.7%) responded that they fail in one every 100 patients treated, 7(4.8%) responded they fail in one every 20 patients treated, 20.9 (6.2%) believed they fail in one every 10 patients treated. Only 12 participants provided additional comments (n=12, 9%).

"Reducing the risk of dry socket." (Five responses)
"Reducing the risk of bacteraemia."
"Reducing cardiology related complications depending on advice of cardiologist."
"Reducing inflammation, swelling, bleeding, bruising, damage to adjacent teeth" (Three responses).
"Osteonecrosis in patients on bisphosphonates." (Two responses).
"Reducing oroantral communication (an abnormal connection between the oral cavity and antrum)."
"I do not prescribe at all unless there is a post extraction complication such as abscess." (Two responses).
"Reducing pain, discomfort and promoting faster healing." (Two responses).

Participants were asked for their opinion about the most important factors responsible for M3s postoperative complications (Table II).

Table II. Factors influencing complications.

Factors	Frequencies	Percentage
Heavy smoking	106	73.1%
Poor oral hygiene	63	43.4%
Long intervention time	54	37.2%
Presence of comorbid systemic diseases	54	37.2%
Inexperienced operator	37	25.5%
Presence of periodontal disease	33	22.8%
Alcohol consumption	30	20.7%
Advanced age	18	12.4%

Dental implant placement procedures

Of 140 participants who answered this question, 49 (33.8%) routinely prescribe AB prophylaxis for DIP placement, 40 (27.6%) indicated that they would avoid prescribing AB, 23 (15.9%) reported that they sometimes prescribe AB prophylaxis and 18 (12.4%) rarely prescribe them. Two themes were identified: 1) AB is required to prevent infection when indicated or as a precaution to prevent infection (n=5) and 2) AB is not required to prevent infection (n=5).

"ABs for implant placement alone are now gaining consensus not to routinely be prescribed in an ASA1/2 patient. The questions do not cover for bone grafting/ sinus grafting when it is more likely to be prescribed."
"AB therapy for all implant placements, rarely used for M3s extractions in my Practice.'
"I feel that implant failure has additional costs associated with it. Therefore dentists may be quicker to prescribe to mitigate costs of losing an Implant due to infection. This does not apply to M3s and therefore I imagine prescribing is less common."
"I do not routinely prescribe ABs in healthy patients. I do not believe the evidence supports doing so."
"AB should only be used to prevent systemic infection I only prescribe if evidence of clinical need indicates prescribing."
"If I was having an implant placed, I would want ABs to minimise the chance of infection, despite my appreciation of the evidence base,"
"The evidence would suggest that no ABs are needed and that a Corsodyl mouthwash is both safer and more efficacious. If used, then only preoperative makes any difference and there is absolutely NO indication for post-operative Abs."

Practitioners were then asked when they usually prescribe the AB, of 89 responses 31 (21.4%) reported they would prescribe AB postoperatively, 32 (22.1%) responded before and after surgery, while 26 (17.9%) indicated that they would prescribe AB before surgery only.

"After surgery when a graft is placed."
"Before and after surgery (pre- and post-operative) when carrying out simultaneous GBR."

Regarding the advise they provided the patient on the use of mouthwash or saline before or/and after DIP placements, 103 answered, with 51 (35.2%) indicating before and after surgery, 36 (24.8%) after surgery only and 16 (11%) before surgery.

"Ideally used rarely more emphasis on oral hygiene and rinses in susceptible patients, Careful case selection and experience in surgical treatment."
"Post operative bathe - not rinse (24h after surgery)."
"Post extraction rinses 24hrs after implant."
"If needed for grafting then Amoxicillin and Metronidazole."
"No indication for routine ABs unless artificial bone graft."

Table III shows responses (n=102, 70%) regarding the most prescribed ABs in DIP for adult patients with and without penicillin allergies.

Table III. AB of choice in patient not allergic or allergic to penicillin.

Antibiotics for no penicillin allergy	Frequencies	Percentages
Amoxycillin	87	60%
Phenoxymethylpenicillin	7	4.8%
Co-amoxiclav	3	2.1%
Metronidazole	2	1.4%
Amoxicillin or metronidazole	1	0.7%
Azithromycin	1	0.7%
Clindamycin	1	0.7%
Blank	43	29.7%
Antibiotic for penicillin allergy	**Frequencies**	**Percentages**
Metronidazole	41	18.6%
Clindamycin	27	11.7%
Erythromycin	17	11.7%
Azithromycin	4	2.8%
Clarithromycin	4	2.8%
Cefalexin	2	1.4%
Clindamycin and erythromycin	1	0.7%
Clindamycin or metronidazole	1	0.7%
Metronidazole and erythromycin	1	0.7%
Clindamycin or erythromycin	1	0.7%
Metronidazole or erythromycin	1	0.7%
Blank	45	29%

Participants were asked about their preferred route of administration for AB in DIP placement procedures, 106 (73.1%) participants reported preference for oral administration, the remaining 39 (26.9%) did not answer this question. Only one participant provided additional comments.

"A loading dose is recommended if it is expected to be a major surgery. If no flap is being raised, and no manipulation of bone etc., ABs can be avoided in healthy patients."

For the preferred duration of course of ABs to be used in DIP procedures, most (n=77, 53.1%) indicated a 5-7 day course, 10 (6.9%) prescribe for 3-4 days and two indicated 10-14 days.

"Single preoperative dose 1 hour prior to surgery." (10 responses).
"Preoperative only. If grafting, then 5 days postoperative."
"3g amoxicillin 1 hour preoperative." (3 responses).
"If simple preoperative stat, if grafting additional 3 days postoperative."
"One preoperative dose is all that is required if indicated."
Three themes were identified: 1) Single preoperative dose (n=16), 2) pre-and post-operative orally if bone graft is required (n=2) and 3) Only if medically indicated (n=1).

Three themes were identified: 1) Single preoperative dose (n=16), 2) pre-and post-operative orally if bone graft is required (n=2) and 3) Only if medically indicated (n=1). Asked if ABs are prescribed for reasons other than direct infection management, 17 (12%) responded:

"Graft or Implant loss, failure or rejection." (10 responses).
"Reduction of pain, swelling and inflammation." (5 responses).
"Heart condition."
"Prevention of medication-related osteonecrosis of the jaw."

Concerning opinions about ABs success in preventing infection following DIP procedures, (126 responses), most (n=51) were uncertain, 38 indicated that ABs prevent one infection in every 10-100 patients, 31 indicated that AB would rarely prevent infection and 6 answered 'never.' Participants were asked for their opinion about factors that lead to postoperative infection following DIP placement procedures (Table IV) and provided 8 comments.

"Would do not offer implants/grafting to smokers or medically compromised patients where healing may be affected."
"I have never had an infection after implant placement over the past 16 Years."
"Improper sterilization."
"Do not do in smokers."
"Poor existing bone."
"Host response. Soft tissue closure – breakdown."
"you would not select implant placement in patients with heavy smoking or poor oral hygiene."
"Complex surgery involving grafting."

Table IV. Factors increasing postoperative infection risk.

Factors	Frequencies	Percentage
Heavy smoking	96	21.5%
Poor oral hygiene	80	17.9%
Presence of periodontal disease	74	16.6%
Presence of comorbid systemic diseases	60	13.4%
Long intervention time	45	10.1%
Inexperienced operator	44	9.8%
Alcohol consumption	32	7.2%
Advanced age	16	3.6%

The final question was open-end inviting participants to write any additional comments they wish to make, 7 participants responded.

"If under GA, the ABs will be given IV pre or perioperatively. Under LA the ABs are almost postoperative." .
"Some operators pack the M3s extraction sites with powder AB. i.e. topically applied therefore preventing the use of systemic course."
"The patient assessment is important, medical conditions, complexity of surgical treatment, time of procedure all need to be taken into account. Prevention of infection maybe needed if the consequences to the individual patient may become severe. Access to follow-up care is also important, if there is limited access for follow-up care i.e. a rural centre prevention maybe more appropriate and prescribing may be more frequent than on a teaching hospital with easy access to dental professionals when there are postoperative complications." .
"I prefer metronidazole as an antibacterial is used along with amoxicillin on occasions."

Statistical analysis

Single option questions were analyzed by frequency and percentage using three main variables, gender, area of practice and country of practice.

Third molar extractions

Table V collates the responses for Q7, 'Do you prescribe antibiotics for surgical extraction of M3 for a healthy adult patient?'

Figures 1-3 provide a breakdown of responses to questions 8, 9 and 12. The before and after the surgery use of ABs was the most selected option for Q8 (7%), not at all for Q9 (23%) and for duration of 5-7 days for Q12 (58%).

Figure 4 displays responses to Q14; 'How often, in your opinion, do antibiotics fail to prevent infection following third molar surgery? Most selected answers were rarely and not sure how often regardless of specialty or nation.

Dental implant placements

The first question was 'do you prescribe antibiotics for dental implant placement for an adult healthy patient? The most selected answer was 'always' in Northern Ireland and Wales (62% and 60% respectively, total sample mean percentage 40%) and the least selected was 'rarely' (mean percentage = 12%). Figure 5 shows the answers breakdown for each of the three study variables.

Table V. Q7 most selected options for total study sample.

	General dentistry (86, 59%)	Specialist (59, 41%)	England (121, 83%)	Wales (10, 7%)	Scotland (6, 4%)	Northern Ireland (8, 6%)	Means	SD+/-
Never	50, 58%	21, 36%	53, 44%	5, 50%	2, 34%	3, 38%	43%	0.093
Rarely	24, 28%	24, 41%	43, 36%	3, 30%	3, 50%	3, 38%	37%	0.080
Sometime	10, 12%	12, 20%	22, 18%	1, 10%	1, 17%	1, 12%	15%	0.040
Always	2, 2%	2, 3%	3, 2%	1, 10%	0%	1, 12%	5%	0.049

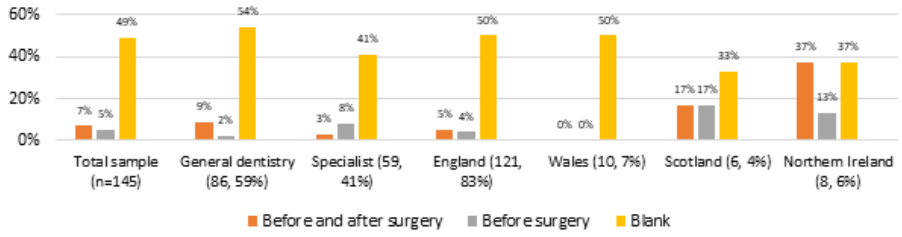

Figure 1. When do you usually prescribe antibiotics? (Q8).

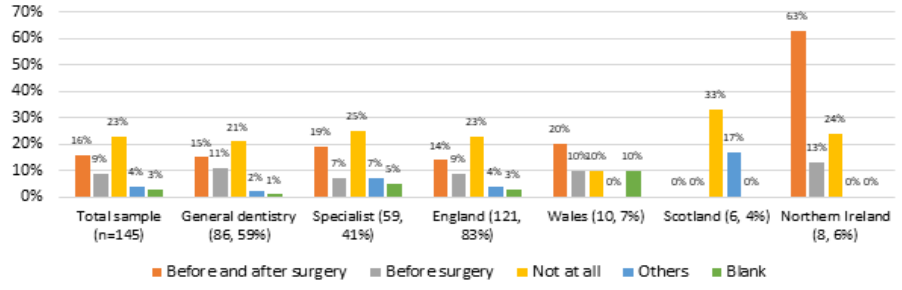

Figure 2. Do you advise the patient to use mouthwash or saline before or/and after dental extractions? (Q9).

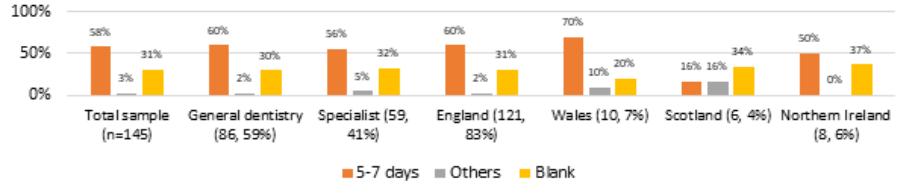

Figure 3. For how long do you recommend antibiotics to be used for third molar extraction? **(**Q12).

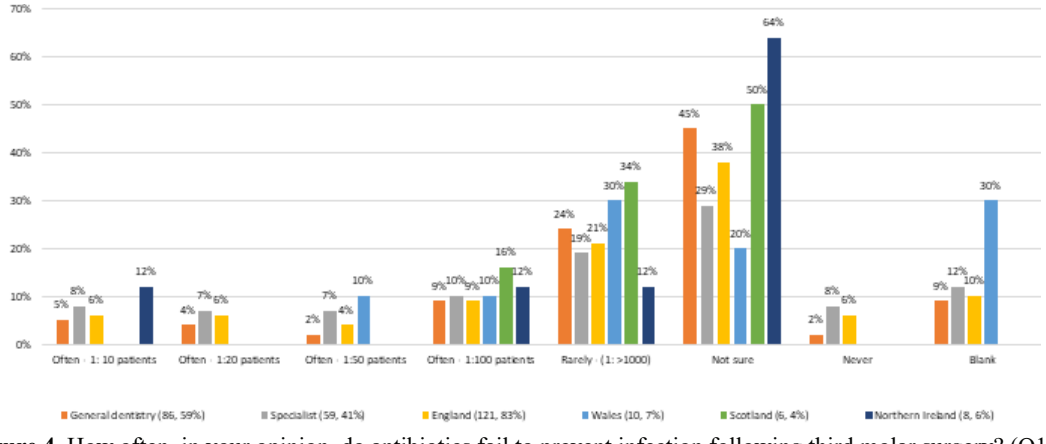

Figure 4. How often, in your opinion, do antibiotics fail to prevent infection following third molar surgery? (Q14).

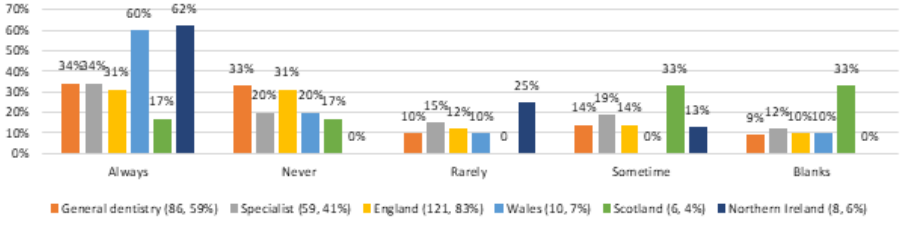

Figure 5. Do you prescribe antibiotics for dental implant placement for an adult healthy patient? (Q16).

Q17 asked participants who answered yes to Q16, about the timing for prescribing ABs (Figure 6), 22% indicated before and after surgery.

For Q21 (Do you advise the patient to use mouthwash or saline before or/and after dental implant placement?), as shown in figure 7, before and after surgery was the most selected option (35%). The responses are shown in figure 6.

For Q22 (how long do you recommend antibiotics be used for dental implant placement?), the most selected answer (Figure 8) was duration of '5-7 days' (57%).

Lastly, Q24 (How often, in your opinion, do antibiotics fail to prevent infection following dental implant placement?), was answered by 36% of participants who selected the '1: >1000' option.

Multiple options questions

Questions 15 (M3 extractions) and 25 (dental implants placements) allowed participants to select all options that apply. When the frequency of selection each option and the total options selected for M3 extraction questions were analyzed (Table VI), using one-tailed t-test the differences between groups were not significant ($p = 0.427$ and $p = 0.500$ respectively).

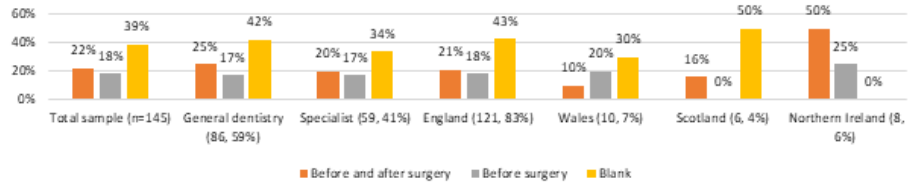

Figure 6. Question 17 responses by percentages.

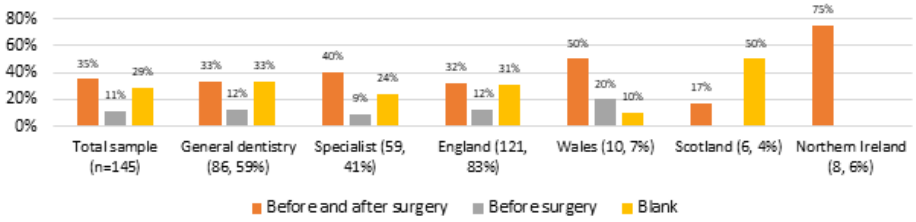

Figure 7. Do you advise the patient to use mouthwash or saline before or/and after dental implant placement? (Q21).

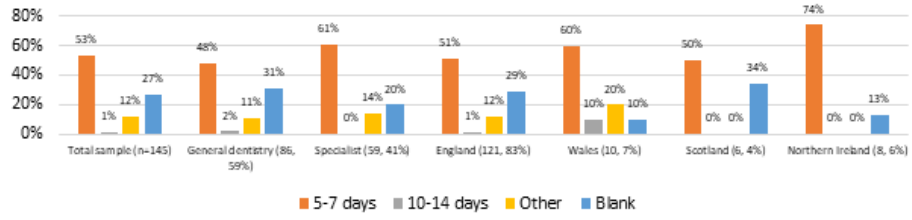

Figure 8. For how long do you recommend antibiotics be used for dental implant placement? (Q22).

Table VI. Possible complications after M3 extractions by selected option.

Options	Females (n=48, 33%)	Males (n=94, 65%)	Prefer not to say (n=3, 2%)	% of total sample
Poor oral hygiene	21, 44%	41, 44%	1, 34%	43%
Alcohol consumption	15, 31%	15, 16%	0%	21%
Heavy smoking	34, 71%	71, 76%	1, 34%	73%
Presence of periodontal disease	11, 23%	21, 22%	1, 34%	23%
Advanced age	6, 13%	12, 13%	0%	12%
Long intervention time	15, 31%	38, 40%	1, 34%	37%
Presence of comorbid systemic diseases	22, 46%	31, 33%	1, 34%	37%
Inexperienced operator	9, 19%	27, 29%	1, 34%	26%

Table VII. Analysis of bivariate correlations.

n=145	p: Pearson's correlation coefficient	α: Statistical significance
Gender	0.073	0.384
Area of practice	0.183	0.280
Clinical experience	0.014	0.868
Do you prescribe ABs for surgical extraction of M3 for a healthy adult patient?	0.024	0.770
Do you prescribe ABs for DIP placement for an adult healthy patient?	0.285	<0.001

The most selected option by the entire sample was heavy smoking (n=106, 73%) followed by poor oral hygiene (n=63, 43%), and the least selected option was advanced age (n=18, 12%). The M3 and DIP results were compared by specialty. There was no significant difference between general dentists and specialists in recognizing complications after M3 extractions and DIP using one-tailed t-test ($p = 0.487$ for general dentists and $p = 0.500$ for specialists) or by gender ($p = 0.205$ for general dentists and $p = 0.083$ for specialists).

Regression analysis

For the single option questions, the results were analyzed using descriptive analysis and bivariate correlation to check for confounding variables. The effects of demographics of the participants on the frequency of the AB prescribing were examined. These factors were determined as gender, area of practice, and clinical experiences and specialty. Pearson's correlation coefficient test was used to examine the level of statistical significance. No significant correlation was found between prescribing AB for dental extraction/implant placement by variables 1-4 but was significant for prescribing ABs in DIP ($p < 0.001$) (Table VII).

Discussion

This project was developed based upon anecdotal evidence of a wide variety of practices for antibiotic prescribing around dental procedures including route of administration of antibiotics, timing of the course prescribed when invasive procedures are planned (before, after, or both), length of course prescribed, narrow vs. broad spectrum agents prescribed, use of single or combination of antibiotics, and the use of loading doses. Additionally, there is a disparity of which (if any) antibiotic intervention is more effective than no intervention at all, or for which patients they should be prescribed to [13, 14]. This project attempted to investigate this disparity of practices and the absence of global and local recent consensus on the most appropriate antibiotic interventions around invasive dental procedures.

Participants were asked whether they prescribe AB in M3s extractions or DIP placement. Of respondents, 49 (33.8%) would routinely prescribe AB prophylaxis for DIP placement whilst 27.6% (n=40) would avoid AB use in patients without relevant medical history. There was considerable agreement that beta-lactam antibiotics such as penicillins and cephalosporins are the first-choice ABs for use in M3s extraction (n=77, 53.1%) provided that there were no allergies or intolerances. The most recommended duration of use was 5-7 days (n=84, 57.9%). For patients allergic or intolerant of beta-lactam AB's the first choice for 69 (47.6%) of dentists was metronidazole followed by clindamycin and erythromycin (28.2%, n=41). This was in line with UK general AB use guidelines for patients allergic to penicillin [17].

Additionally, a small percentage of respondents justified that their administration of post extraction AB was to avoid infections due to an unsterile environment, a prolonged or difficult procedure, or for patients with pre-existing immunosuppression, patients with metabolic disorders such as diabetes patients with underlying cardiac conditions and pre-existing dental conditions. Some respondents (n=56, 38.6%) were unsure whether AB use would reduce the risk of infection following M3s extractions.

A patient's age, gender, the presence of systemic disease, duration of the extraction procedure and operator experience were identified factors influencing the occurrence of infection after extraction, whist for post-implant infection, heavy smoking and poor oral hygiene were associated with increased infection risk. Amoxicillin was reported as the most frequently prescribed AB in M3 extractions (n=77, 53.1%) and DIP surgeries (n=87, 60%), which complies with current guidelines. A small percentage of participants recommended phenoxy-methylpenicillin (n=9, 6.2%) as a narrow spectrum AB to reduce emergence of microbial resistance.

The survey showed 42% of participants (n=61) discouraged prophylactic AB use in M3 extractions in patients with no systemic conditions, preferring postoperative AB use only when required. Conversely, 57.9% of respondents (n=84) supported the short-term use of ABs (5-7 days) for M3 extraction and 53% (n=77) in DIP placement in patients without relevant medical history. There were conflicting data on the timing of AB

administration (preoperative, postoperative, or both) in DIP surgery. A total of 31 (21.4%) reported that they would prescribe AB postoperatively, while 32 (22.1%) responded that they would prescribe before and after surgery.

Of respondents, 65 (44.8%) prescribe antiseptic mouthwash or saline for post M3 extraction, 24 (16.6%) reported that they use mouthwash both before and after surgery, and 13 (9.0%) indicated the use of mouthwash before the extractions only. In DIP placement, 51 (35.2%) indicated that they would prescribe mouthwash in conjunction with AB among healthy patients before and after DIP placement surgery and 36 (24.8%) stated that they would do so after surgery only, while 16 (11%) would prescribe them only before surgery.

Participants were asked if the use of ABs can prevent complications due to infection. The majority left this section blank but seven reported that AB would help in reducing inflammation, swelling, oroantral communication, pain and discomfort due to infection and a similar number of surveyed dentists claimed that AB would help preventing endocarditis, osteonecrosis, abscess and promote faster healing. In addition, for DIP only, ten participants responded that AB would prevent infection which will improve graft-taking, preventing implant loss. The results from survey were compared to the Klinge et al. [18] 4th European Association for Osseointegration (EAO) conference consensus (Table VIII).

Whilst this study was in progress, further guidance was published [19-20] together with this groups' own systematic reviews and meta-analyses [13-14]. Guerrini *et al.,* [19] is a narrative review that also describes the Italian, European and American guidelines. Salgado-Peralvo *et al.,* [20] is a consensus report on preventive antibiotic therapy in dental implant procedures: summary of recommendations from the Spanish society of implants. The international consensus remains that antibiotic prophylaxis is discouraged, and from the survey, dentists appear to understand this, but the level of antibiotic prescribing raises questions, with co-morbidities a frequently cited reason. Future research will need to investigate this further to inform future guidelines.

Table VIII. Findings compared to the EAO 2015 consensus.

(Klinge et al., 2015) [18]	Survey conclusion based on dental implant surgery	Final recommendation
Conclusions (page 65) In "complex" cases (for example patients requiring grafting procedures or immediate placement in extraction sockets) and/or a compromised patient a beneficial effect of antibiotic prophylaxis cannot be excluded. Consensus statement (page 65) In "straightforward" cases antibiotic prophylaxis has not shown a beneficial effect.	There were 40 (27.6%) indicated that they would avoid prescribing AB to patients with no relevant medical history and a small percentage of respondents stated that AB use should be confined to those who require artificial bone graft and stated that if no flap is being raised and no manipulation of bone etc. Clinical assessment, based on the patients' dental risk factors (e.g., oral health and bone health), physical risk factors (e.g., chronic or long-term conditions), other health determinants (e.g., smoking, high alcohol consumption) and demographics (e.g., age) are required to prevent unnecessary use of antibiotics.	The conclusion by Klinge *et al.,* [18] suggested that antibiotic prophylaxis may be beneficial in certain complex cases, such as patients requiring grafting procedures or when the patient is compromised. This finding is consistent with our survey conclusion where 40 (27.6%) indicated that they would avoid prescribing AB to patients with no relevant medical history in patients undergoing dental implant surgeries and a small percentage of respondents highlighted that AB use should be confined to those who require an artificial bone graft and stated that if no flap is being raised and no manipulation of bone etc., Together, these findings suggest that a personalized approach, based on patient's dental and physical risk factors, may be more appropriate to prevent unnecessary use of antibiotics.
Knowledge gap: The role of antibiotic prophylaxis in implant placement in "complex" cases, and/or com-promised patients, needs to be scrutinized and adequately assessed.	Future studies that intentionally compare healthy dental patients and those with physical comorbidities or behavioral issues (clenching and parafunctional - grinding, thumb sucking or biting, and tongue thrusting – or any repeated use of the oral structures for things other than eating, swallowing, speaking, or breathing) are required to improve the understanding of where antibiotics use may be optimized.	Klinge *et al.*, [18] highlight the need for further research to scrutinize and evaluate the use of antibiotics in "complex" cases and compromised patients. This knowledge gap is consistent with our identified future knowledge gap where it was suggested there is a need for studies comparing patients requiring dental implant placement with physical comorbidities or behavioral issues to better understand where antibiotics use may be optimized. Together, these findings indicate that there is a knowledge gap in the understanding of when and how to use antibiotics in implant placement and that more research is needed in this area to improve clinical practice and patient outcomes.

Conclusion

Of 900 dental professionals invited, 145 general and specialist practicing dentists from different practice settings responded to the opinion survey. There were 42% of participants (n=61) who discouraged AB prophylactic use in M3 extractions in people with no systemic conditions and who also preferred postoperative AB use when required. Eighty four (57.9%) of respondents supported the short-term use of ABs (5-7 days) for M3 extraction and 53% (n=77) in DIP placement in patients with no relevant medical history. As an *ad hoc* finding, dentists reported on the negative impact of heavy smoking and oral parafunctional behavior on DIP success.

Acknowledgements

We would like to thank all participating dentists for taking the time to complete this survey.

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