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The Appropriateness of Antibiotic Prescribing within Dundee Dental Hospital

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***Abstract*—**Background: The societal impact of antibiotic resistance is a major public health concern. The increase in incidence of resistant bacteria can ultimately be fatal. Objective: To analyse the appropriateness of antibiotic prescribing in Dundee Dental Hospital, ultimately improving the safety and quality of patient care. Methods: Two examiners independently crosschecked approximately fifty consecutive prescriptions, and corresponding patient case notes, for three data collection cycles between August 2014 – September 2015. The Scottish Dental Clinical Effectiveness Program (SDCEP) Drug Prescribing for Dentistry guidelines was the standard utilised. The criteria: clinical justification, regime justification and review arrangements was measured, and compared to the standard. Results: Cycle one revealed 42% of antibiotic prescriptions were appropriate. Interventions included: multiple staff meetings, introduction of a checklist attached to the prescription pack, and production of patient leaflets explaining indications for antibiotics. Cycle two and three revealed 44%, and 30% compliance, respectively. Conclusion: The results of the audit have yet to meet target standards set out in prescribing guidelines. However, steps are being taken and change has occurred on a cultural level.

***Keywords*—**Antibiotic resistance, antibiotic stewardship, dental infection and hygiene standards.

I. Introduction

THE societal impact of antimicrobial resistance is a major public health concern on a local, national and global scale [1]. The increase in incidence of resistant bacteria to existing antimicrobials creates the potential for once treatable infections becoming untreatable, and ultimately fatal [2]. Inappropriate prescribing of antibiotics across the healthcare profession is a contributing factor.

As approximately 10% of all antibiotic prescribing in the UK is dental related, the dental profession has a responsibility to promote, adhere to, and monitor appropriate prescribing patterns [3]. A collaborative, transparent and education based approach, encompassing the dental profession, patients and wider society, in understanding the value, importance and limited capacity of antibiotics, is critical. The foundation of this integrated approach is appropriate prescribing locally, combined with a bilateral, informative, patient-dentist relationship. In this context, the overall aim of the audit is to analyse the appropriateness of antibiotic prescribing in Dundee Dental Hospital, and implement an antibiotic stewardship framework, ultimately improving the safety and quality of patient care, and contribute to reducing antimicrobial resistance.

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II. Materials and Methods

A. Audit Overview

A multi-cycle, retrospective, clinical audit was planned and conducted analysing antibiotic prescribing patterns within the Oral Surgery, and Dental Accident and Emergency departments at Dundee Dental Hospital, in the period August 2014 to September 2015. These departments were selected, as they constitute the majority of all prescriptions prescribed in the dental hospital. Two examiners independently crosschecked approximately fifty consecutive prescription carbon copies, and corresponding patient case notes, for each cycle. Details on the prescription, such as a patient's hospital number and prescription date, was used to locate the patient case notes, and subsequently the entry in the notes relating to the episode of care in which the prescriber issued the prescription.

B. Standard Utilised

The standard utilised in the audit was the Scottish Dental Clinical Effectiveness Program (SDCEP) Drug Prescribing for Dentistry guidance. This is an evidence based national guidance document, and is widely accepted to be the gold standard guidance for dental prescribing in a primary care setting. This guidance is applicable to a dental hospital setting as the majority of patients in the Oral Surgery, and Dental Accident and Emergency departments, are primary care patients who do not have access to a general dental practitioner. The examiners agreed that 100 percent of prescriptions prescribed should be appropriate.

C. Criteria Measured

Three separate criteria were measured to determine if the prescription was overall appropriate: *clinical justification*, *prescription regime justification* and *review arrangements*. To be deemed an overall appropriate prescription, all three criteria must have been satisfied according to (1):

Prescription Overall Appropriate = Clinically justified + prescription regime justified + review arrangements made (1)

To determine if the prescriber was clinically justified in prescribing the antibiotic, the patient case notes were scrutinised for the clinical details relating to the prescription episode in question, and a diagnosis determined. From the diagnosis the examiner decided if it was clinically justified to prescribe the antibiotic based on the presence of specific

clinical features, and the patient's medical history including immunosuppression, as documented in the SDCEP Drug Prescribing for Dentistry guidance. If the examiner could not determine a diagnosis from the clinical notes, for example if the notes were incomplete, it was assumed the prescription was not clinically justified.

To assist the examiners in reliably determining clinical justification for prescribing, and to ensure standardisation between examiners, a decision flow chart was produced as shown in Fig. 1. In general, local measures should be initiated first, if possible, and supplemented with antibiotics where the clinical features outlined in the SDCEP guidance, and Fig.1 are present.

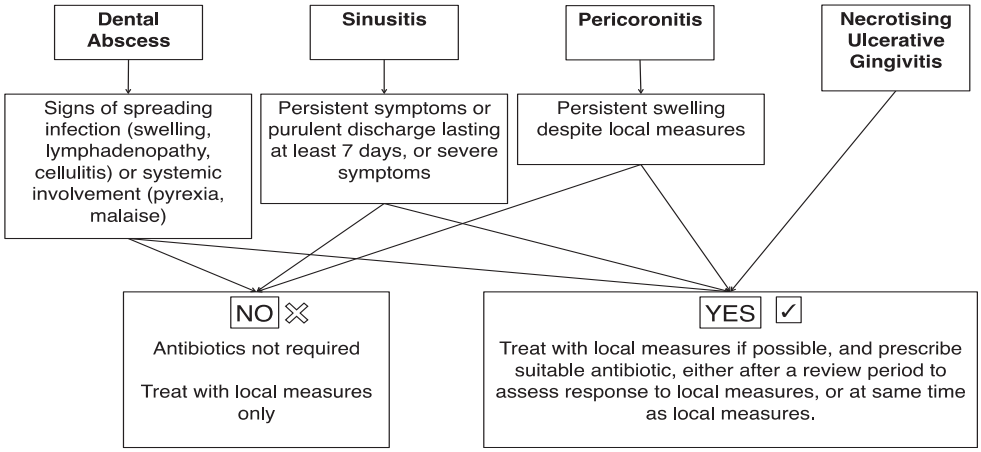

Fig. 1 Decision making flowchart for prescribing antibiotics appropriately

For the prescription regime justification criterion, the examiner determined if the prescriber followed the specific dose, frequency and duration outlined in the SDCEP guidance. For the review arrangements criterion, the examiner determined if the prescriber arranged, or at least, offered the patient a review appointment within a suitable timeframe, after issuing a prescription.

D. Inclusion Criteria

The inclusion criteria were set to include all antibacterial prescriptions within the Oral Surgery, and Dental Accident and Emergency Departments, between the following dates:

- Cycle 1 August 2014 – December 2014
- Cycle 2 March 2015 – May 2015
- Cycle 3 June 2015 to September 2015

E. Exclusion Criteria

The following exclusion criteria was applied:

1) Non antibacterial prescriptions
2) Antibacterial prescriptions not listed in the dental formulary section of the British National Formulary
3) Prescriptions the examiners had written during the course of their own employment in Dundee Dental Hospital
4) Clinical diagnoses out with the scope of the SDCEP guidance, for example osteomyelitis of the jaw, or implant placement
5) Illegible prescriptions
6) Incomplete prescriptions, for example prescriptions missing the patient's hospital number, or date.

F. Audit Design

A retrospective data collection format was selected to allow rapid data collection and analysis, and minimise assessor bias.

G. Data Collection Size

The audit aimed to have approximately 50 prescriptions (25 per department) per cycle after the exclusion criteria was applied.

H. Data Collection Tool

A customised data collection template was constructed to record the data collected, and facilitate analysis of the results. Table I shows an extract of the data collection template, and a sample of results, illustrating its use.

TABLE I
SAMPLE OF DATA COLLECTION TEMPLATE

Diagnosis	*1	Name of Antibiotic Prescribed	Dose (mg)	Frequency (unit of time)	*2	*3	*4
Periapical Periodontitis	N	Amoxicillin	500mg	3/day, 5days	-	N	N
Infected Socket	Y	Amoxicillin	500mg	3/day, 5days	Y	Y	Y
Non healing socket	Y	Amoxicillin	500mg	3/day, 5days	Y	Y	Y
Non healing socket	N	Metronidazole	200mg	3/day, 7 days	-	Y	N
Periapical Periodontitis	N	Clindamycin	150mg	4/day, 5days	-	Y	N
Dental Abscess	Y	Amoxicillin and Metronidazole	500mg, 200mg	3/day,5days and 3/day, 3days	N	N	N
Infected Socket	Y	Amoxicillin	500mg	3/day, 5days	Y	Y	Y
Dental Abscess	Y	Metronidazole	400mg	3/day, 3 days	N	Y	N

*1 clinically justified, *2 regime justified, *3 review arranged, *4 overall appropriateness

I. Minimising Bias

To minimise bias, consecutive prescriptions within the cycle time period were collected. Two examiners independently analysed each prescription with the corresponding patient case notes, using the standardised decision flow chart to determine if the prescriber had prescribed appropriately. Any disputes between the independent analyses were resolved through dialogue.

J. Ethical Considerations

The University of Dundee Health Informatics Centre standard operating procedures were complied with. Specifically, the Governance Support Document was consulted regarding audit projects, resulting in no additional approval being required. At all times the audit was conducted in respect of patient confidentiality.

K. Statistical Analysis

Single factor ANOVA and unpaired t-tests were used to assess for statistically significant results.

L. Intervention

Following cycle 1, an antibiotic stewardship framework was implemented consisting of multiple educational meetings, patient information and education leaflets explaining the indications for antibiotics, and prescribing checklists on the prescription pack. These interventions were reassessed after cycle 2 and cycle 3 to explore further solutions to attain the target standard.

III. Results

A. Exclusions

The number of prescriptions and numbers excluded in each cycle are shown below in Fig. 2.

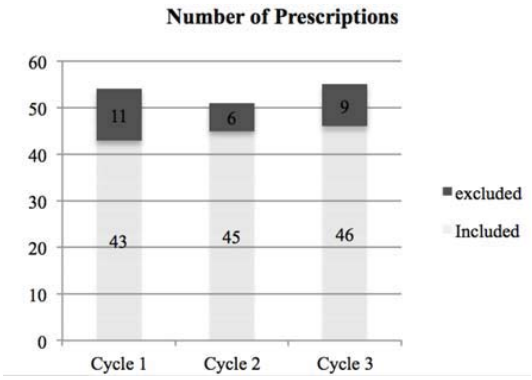

Fig. 2 Number of prescription exclusions and inclusions

B. Clinical Justification

The percentage of clinically justified prescriptions issued was 74% in cycle 1. Although it marginally improved by cycle 2, following the antibiotic stewardship interventions, it reduced to 59% by cycle 3 (Fig. 3).

Examples of situations where prescriptions were issued despite not being clinically justified include: irreversible pulpitis, pericoronitis, dry socket or retained roots in the absence of systemic involvement or spreading infection, or prophylactically following difficult or lengthy minor oral surgical procedures.

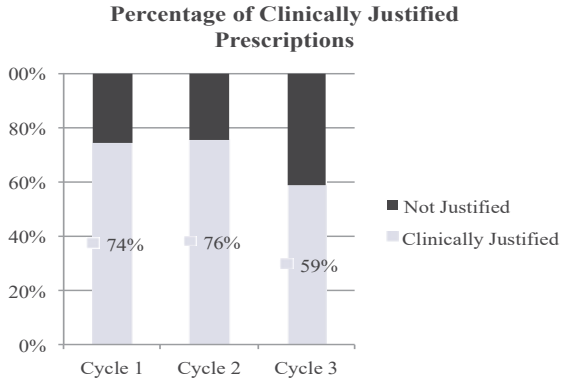

Fig. 3 Percentage of Clinically Justified Prescriptions - illustrates the percentage of prescriptions issued where the clinical presentation of the patient warranted antibiotics

C. Regime Justification

As a percentage of the clinically justified prescriptions, 72% strictly adhered to the SDCEP recommended regime in cycle 1 (Fig. 4). Those prescriptions that were not adherent to guidelines, contained the standard antibiotics – amoxicillin and metronidazole – but the course duration was extended – 7 days rather than 5 days for dental abscesses, or 5 days rather than 3 for acute necrotizing ulcerative gingivitis (ANUG).

The number of prescriptions adherent to the SDCEP guidelines significantly increased to 91% in cycle 2 (P=0.043, unpaired t-test). In this cycle thexre were only 3 inappropriate regimes prescribed; 2 were due to the course duration and one was antibiotic selection – co-amoxiclav rather than amoxicillin.

As before, in cycle 3 the adherence rate dropped markedly to 59% (P=0.0027). The majority (7/11) of the inappropriate prescriptions were due to antibiotic selection – co-amoxiclav rather than amoxicillin. This was under the instructions of a new consultant in the department. The remaining 4 inappropriate prescriptions contained discrepancies in course durations.

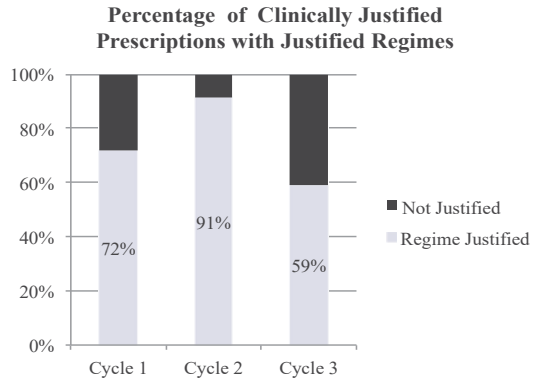

Fig. 4 Percentage of Clinically Justified Prescriptions with Justified Regimes - depicts the percentage of prescriptions where the regime given was justified for the diagnosis

D.Review Arrangements

The opposite occurred with patient reviews (Fig. 5). The number of reviews arranged following the antibiotic stewardship interventions reduced from 67% to 56%. However, numbers improved to 70% by cycle 3. These changes seen were not statistically significant (P>0.05, ANOVA).

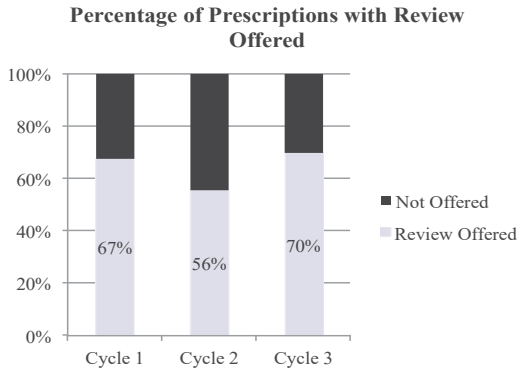

Fig. 5 Percentage of Prescriptions with Review Offered - shows the percentage of cases where patient review arrangements were made

E. Overall Appropriateness

Unfortunately, the antibiotic stewardship interventions did not help in reaching the audit target standards (Fig. 6). All three cycles were significantly below target, with cycle 3 having the lowest percentage of appropriate prescriptions.

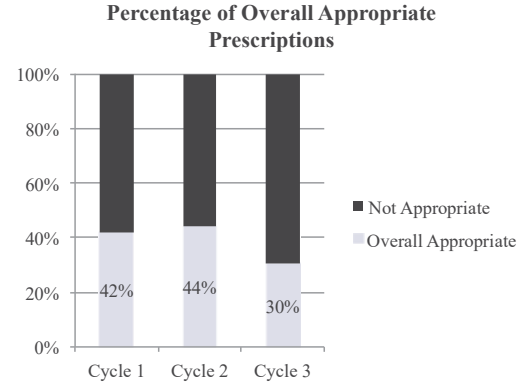

Fig. 6 Percentage of Overall Appropriate Prescriptions - represents the percentage of the total number of prescriptions issued for which all 3 criteria were met - clinical and regime justification, and review arrangements being made

IV. Discussion

A. Clinical Justification

At best, 3 out 4 prescriptions issued were clinically justified in the Oral Surgery, and Dental Accident and Emergency departments, within our audit timeframe. The key reason for this lack of compliance was the issuing of prescriptions for localized dental infections, with no evidence of spreading infection or systemic involvement. Studies have demonstrated that inflammatory conditions, such as pulpitis and pericoronitis, do not warrant antibiotics [4]. Local treatment is sufficient in resolving local dental infections rapidly, with no additional benefit from systemic antibiotics [5]. Even following difficult third molar surgical procedures, antibiotic prophylaxis has no benefit [6]. Prophylactic antibiotic prescription following implant placement only prevents 2% of implant failures and is not beneficial in healthy patients [7].

B. Antibiotic Regime

Our antibiotic stewardship intervention had a significantly positive but not a lasting effect on the prescription of appropriate antibiotic regimes. The percentage of appropriate prescriptions increased to approximately our target of 100%. However, as new staff arrived the positive effect diminished. Research has revealed that only 1.2% of general dental practitioners in England were compliant with the dental practitioner formulary recommended antibiotic regime [8]. Although the majority selected the standard antibiotics, the course duration varied from 1 day to 21 days and the frequency from 4 hourly to 48 hourly [8].

In the third cycle, we saw a significant rise in co-amoxiclav prescriptions. Interestingly, penicillin V and co-amoxiclav gave comparable outcomes in a randomized trial on the treatment of dental abscesses [9]. In fact, co-amoxiclav, clindamycin, clarithromycin, cephalosporins and azithromycin are only ever recommended as second line antibiotics for dental abscesses if culture and sensitivity results indicate them, or once operative surgery and higher doses of standard antibiotics have been tried [4].

C. Review Arrangements

Reviewing a patient within an appropriate timescale following the prescription of an antibiotic is an important element of antibiotic stewardship [10]. Within Dundee Dental Hospital we found review arrangements were randomly varying. This is not unexpected as the Oral Surgery and Dental Accident and Emergency departments are tailored towards an unplanned treatment service with no specific appointments issued. For high quality antibiotic stewardship, a built-in review appointment system is fundamental.

D. Overall Prescribing Appropriateness and Future Intervention

The causes of inappropriate prescribing are multifactorial. To achieve an overall appropriate rating, the parameters of the audit require three criteria to be achieved - clinical and regime justification, and review arrangements being made from literature and government guidance documents, judicial prescribing extends beyond clinical justification only. Adhering to national guidance regarding prescribing regimes, and reviewing the patient, are equally important aspects of appropriate prescribing.

Changes in senior and junior staff occurred between cycle 2 and cycle 3, meaning the new staff may not have been aware of the antibiotic stewardship competencies encouraged in the hospital after cycle 1. Further analysis also implicates part time staff members, who normally operate under general practice conditions, contributing to some clinical sessions in the dental hospital.

We plan to implement a decision support system and a stamped checklist. The checklist is to ensure the clinical and regime justification, and review arrangements are all considered consistently every time a prescription is issued. Nurses are a vital element of the dental team and should be involved in antibiotic stewardship, specifically in ensuring the dentist follows the checklist, and utilises the stamp for the patient's notes. The decision support system is in the form of a flowchart, which guides clinicians to make the correct decision about whether to prescribe or not. It will be included in the third edition of our national guidelines for dentists, SDCEP guidelines on prescribing.

E. Antibiotic Resistance

Worldwide antibiotic use has increased by 36% in one decade [11]. The USA alone has the highest daily antibiotic consumption – 51 tons (80% of that is in agriculture) [12], [13]. More than 75% is utilized by the five major emerging economies – the BRICS countries (Brazil, Russia, India, China, and South Africa) [11]. They are responsible for two-thirds of the increase in antibiotic use in a decade from 2000 to 2010 [12].

It has been consistently found that 50% of antibiotic usage in healthcare and animal farming is inappropriate [11]. This inappropriately high consumption rate results in a strong selective pressure for resistant pathogens. It is facilitated by the low cost of non-pharmaceutical grade antibiotics ($25 per kg) and poor regulation of antibiotics. The resistant species of bacteria colonize cattle and humans alike and exchange resistance genes [13]. Bacterial genome sequencing has predicted the existence of 20,000 potential resistance genes [14]. Penicillin-resistance bacteria are prevalent in acute dental abscesses [15]. Some anaerobes are even developing resistance to Metronidazole [16].

F. Antibiotic Stewardship

National guidelines recommend that we demonstrate adherence to antibiotic stewardship principles [17]. To reduce bacterial resistance, we should (a) limit antibiotic use, (b) improve hygiene standards and (c) produce new, more effective antibiotics [18].

a) Several methods of reducing antibiotic prescribing patterns in general medical practice have been published. Standardised and interactive educational meetings can be effective [19]. Delayed prescription is a method of involving patients in the decision making and raising their awareness of antibiotic stewardship [20]. They can be advised to return in 3-7 days if their symptoms do no improve or be given a post-dated prescription [20]. But it has also been shown that patients pressure doctors to prescribe antibiotics and patient satisfaction was closely associated with higher antibiotic prescribing volumes [21]. Almost half of general medical practitioners in a large study carried out in England admitted to prescribing antibiotics when they knew it was not indicated in an attempt to satisfy the patient by having a tangible treatment option. Longer consultations result in fewer prescriptions with no detriment to patient satisfaction [21]. For this reason, we focused on patient education as part of our antibiotic stewardship framework.
b) Improved oral hygiene reduces the risk of dental infections, reducing the need for antibiotic prescribing. In particular, pre-operative plaque control reduces the risk of dry socket after third molar surgical removal [22]. Antibiotics should not be used where better hygiene would suffice. In parallel with this, in aquaculture, antibiotics are used excessively to prevent bacterial infections in fish reared in unhygienic conditions. These are non-biodegradable and end up in the fish meat as well as lingering in the environment, resulting in a strong selective pressure for resistant bacteria [23].
c) Unfortunately, antibiotic research lacks profitability for the pharmaceutical industry [24]. Teixobactin, is one antibiotic discovered in 2015, which has a similar mechanism of action to vancomycin – inhibiting lipid II (a precursor of peptidoglycan) [25]. This is the weakest link in cell wall synthesis in gram-positive bacteria. Therefore, it has minimal susceptibility to resistance [25]. Teixobactin is inactive against gram-negative bacteria and has not yet been clinically trialed. However, it is anticipated the technique of culturing bacteria in iChips in soil will lead to further antibiotic discoveries [25].

V. Conclusion

In the context of global antibiotic resistance, the adoption of antibiotic stewardship competencies is instrumental across all disciplines. This audit has exemplified the challenges of adhering to prescribing guidelines. Although the results of the audit have yet to meet target standards set out, an important outcome was to identify system wide problems and instigate change on a cultural level, reminding clinicians of principles of antibiotic stewardship, the importance of adhering to national guidelines strictly, and justifying any diversion from these guidelines robustly. Ultimately, patient safety and quality of care will be enhanced.

Acknowledgment

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