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**Original Research**

# Knowledge, practice and attitudes regarding antibiotics use among Lebanese dentists

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## Abstract

**Objectives**: Explore antibiotic use, assess conformity with evidence-practice guidelines, and describe knowledge and attitudinal factors among Lebanese dentists.

**Methods**: National cross-sectional telephonic survey, using a standardized questionnaire addressing demographic, educational and professional data, usual antibiotics prophylactic and curative prescription pattern and influential factors, knowledge concerning antibiotics use in selected patient-populations, and attitude regarding antimicrobial resistance. Analyses used descriptive statistics, and bivariate analysis to observe predictors of higher knowledge.

**Results**: the overall response rate for the study was around 21%. 322 dentists participated. On average, 17.51% of consultations resulted in antibiotic use; previous antibiotic experience mostly influenced prescriptions (81.3%). Referral of pregnant and lactating women and cardiac patients, when antibiotics are needed, was high (26.9%, 28.5% and 79.4%, respectively). Macrolides were the dominant first-line antibiotics in penicillin allergy (47.4%). Penicillins were most common for pregnant and lactating women. Penicillins (95.0%), 2g (63.9%), and 1 hour pre-procedure (34%) were the main components of prophylaxis for cardiac patients. Prophylactic and curative use varied widely; few dentists exhibited guideline-conform prescriptions. Mean knowledge scores of prophylaxis for cardiac and non-cardiac patients, and antibiotics' side effects were predominantly poor (46.75±14.82, 39.21±33.09 and 20.27±18.77, respectively over 100). Practicing outside Beirut, undergraduate qualification in Lebanon, and post-graduate qualification predicted higher knowledge. 75.9% acknowledged the contribution of dentistry-based prescribing to antibiotic resistance and 94.7% knew at least one cause of resistance.

**Conclusions**: Dentists show positive attitude towards antimicrobial resistance. Yet, they lack uniformity in antibiotic stewardship. Poor knowledge and guideline-incongruent prophylactic and therapeutic prescribing are observed. Development of targeted interventions is needed to promote judicious antibiotic use within Lebanese dentistry.



## Keywords

Antibiotic Prophylaxis; Health Knowledge, Attitudes, Practice; Inappropriate Prescribing; Professional Practice; Guideline Adherence; Penicillins; Streptomyces; Dentists; Surveys and Questionnaires; Lebanon




## INTRODUCTION

Antimicrobial resistance is a serious threat to human life, posing catastrophic public health and economic burdens.[1] Since the mid-1990s, dentistry-based antimicrobial prescribing emerged as one potential driver of the global phenomenon of antibiotic resistance.[2] Clearly, the use of antibiotics as an adjunct to local treatment is the most appropriate method of managing oral infections.[3,4] However, its inappropriate prescription would not provide sufficient benefit yet, it runs the risk of causing side effects ranging from gastrointestinal disturbances to fatal anaphylactic shock and emergence of resistant bacteria, and yields greater health.[5,6] Thus, dentistry-based antibiotic prescribing for prophylactic and therapeutic conditions is dictated by defined criteria, and dentists are urged to judiciously prescribe antibiotics.[4,7-10] However, the increasing and inappropriate use of antibiotic by dental professionals remain an international finding.[11-17]

Knowledge and attitudinal factors are pivotal in explaining this evidence-practice gap.[18] Specifically, in the Middle East, dentists are prone to prescribe on patient's demand, especially when short of time. Antibiotics are abused to prevent postoperative infections or as a consequence of the lack of aseptic clinical techniques.[19] Conflicting data from the region show that in some countries in spite of good knowledge of local and international guidelines, and awareness of the importance of the judicious use of antimicrobials, dentists tend to use antibacterials for inappropriate indications.[15,20] Studies have shown patterns of overprescribing among dentists where broader spectrum antibiotics, longer durations and higher doses are given.[21-26] In Lebanon, information on antibiotic stewardship in dentistry is scarce. The only available evidence is in acute and chronic dento-alveolar abscess and emanate from a small study conducted in Beirut. It reports results parallel with the international literature: inappropriate use in terms of dosage, duration and frequency is evident, with amoxicillin being the primary prescribed agent.[27]

Monitoring trends in antibiotic prescriptions by dentists and elucidating pertaining knowledge and attitudinal factors may reveal previously unrecognized opportunities to curb prescribing, and might identify areas of concern in a

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service or where there is a potential for improvement and optimize antibiotic treatments and stem the emergence and spread of resistance.[5,18] A national survey was conducted among Lebanese dentists to explore antibiotic use and its concordance with guidelines, and to describe pertaining knowledge and attitudinal factors.

## METHODS

An observational cross-sectional telephone-based survey was performed between July and September 2017. The study participants were chosen from the list of Lebanese dentists registered at the Lebanese Order of Dentists. Out of 4432 registered dentists, complete data were obtained for 3222 dentists. Dentists were then sorted according to their region of practice and gathered into subgroups based on the corresponding governorate. They were distributed as follows: 20% from Beirut, 55% from Mount Lebanon, 13% from South Lebanon (including Nabatiyeh), 11% from Bekaa, and 1% from North Lebanon.

The study sample was drawn to respect the same distribution of dentists per governorate. A minimum sample size of 322 participants (10% of the list of dentists with complete data) was considered sufficient to fulfill the study's main objective.

A systematic random sampling was then adopted, and dentists with an odd number in the list {1, 3, 5, 7, etc.} were orderly called until reaching the required number of participants from each region. In total, we had to make 1530 phone calls to be able to reach 460 dentists, among whom 322 gave their oral consent to participate in the study (1070 calls resulted in the following: "dentist absent" or "dentist busy" or "no answer"). The telephonic interview lasted between 10 and 15 minutes.

A standardized questionnaire was designed in English as well as in French. Translations were supervised by professional translators. The questionnaire was pre-tested with 10 dentists for validity and acceptability. Validity was examined by evaluating whether the questions were comprehensive. Acceptability was evaluated by asking the dentists how they found answering the questionnaire and if they wanted to omit or add questions. Confidentiality of the respondent was ensured. The first section of the questionnaire included questions regarding demographic data, specialty, education details, level of experience, working place, attendance of continuing education sessions, average activity. In the second section, dentists were asked to indicate their usual prescription pattern of antibiotics and factors that influence their behavior. The third section was composed of table with a list of different non-invasive and invasive dental procedures and a question about their routine prophylactic or curative prescription of antibiotics (type, dose, duration, route of administration) in general population and in high risk of infection patients (immune-suppressed and with high risk of infective endocarditis). The final section included their knowledge concerning antibiotics, high risky patients, recommendations and their own role in antimicrobial resistance.

The Lebanese University ethics committee waived the need for approval since the study was observational, anonymous and respected the individuals' confidentiality.

**Statistical Analysis**

Data were collected and all analyses were performed using SPSS version 20. Descriptive analysis was generated. Means and standard deviations were used for quantitative variables while percentages were shown for qualitative variables.

Knowledge questions were isolated and scored. One (1) mark was given for every correct response and zero (0) for an incorrect response. Responses of "Do not know" were counted as incorrect, and no points were given. The total knowledge score was the sum of all correct answers. For dentists who provided answers to all questions, mean knowledge score (%) was calculated and divided into three categories: poor (<60%), intermediate (60-80%) and good (>80%) level.

The antibiotic prescriptions in different dental procedures were compared to recommended guidelines[5-9] in order to evaluate their appropriateness (indication, type, dose, frequency and duration). Finally, a bivariate analysis was computed to observe the relations between the knowledge of dentists and their demographic and professional characteristics; i.e. Independent Samples T-Test to explore the association between knowledge scores and independent variables having two mutually exclusive groups, and One-Way ANOVA to explore the association between knowledge scores and independent variables having 3 or more mutually exclusive groups.

## RESULTS

322 dentists completed the interview. Their mean age was 44.87 years (9.60; range: 24-67), and 67.1% of them were males. The professional characteristics of participants are provided in Table 1. Reported antibiotic prescribing frequency varied widely among the respondents: on average, 8.8 (11.73) systemic courses were prescribed weekly, and overall 17.51% (18.32%) of dental consultations resulted in the prescription of an antibiotic.

Table 2 details antibiotic prescribing practices. It should also be noted there was a wide range of antibiotics prescribed as a first choice for people who are allergic to penicillin, as well as for both pregnant and lactating women, with varying spectrums of activity. To note that macrolides were the most common first-line antibiotics prescribed to patients allergic to penicillin (47.4%). Interestingly, 5.9% of dentists reported penicillin agents as their first choice. In addition, cetirizine was recommended by one respondent as a first choice antibiotic for a patient allergic to penicillin. Amoxicillin and amoxicillin/clavulanate (Penicillins) were the most common antibiotics prescribed for pregnant and lactating women, followed by macrolides. More than one-quarter of respondents reported referring these women to their gynecologists, when antibiotic prescription is needed (26.9% and 28.5%, respectively). Also, referral of cardiac patients, when necessary, was high (79.4%). 86.9% of the sample always enquired whether their patients are taking antibiotics before proceeding to

Table 1. Professional Characteristics of Participating Dentists

| | N | % |
|---|---|---|
| Main Consultation Region (n=322) | | |
| Mount-Lebanon | 177 | 55.0 |
| Beirut | 65 | 20.2 |
| South (including Nabatiyeh) | 42 | 13.1 |
| Bekaa | 35 | 10.9 |
| North | 3 | 0.9 |
| Primary dental qualification (n=318)* | | |
| Lebanon | 192 | 60.4 |
| Other countries | 126 | 39.6 |
| Years in practice (n=314)* | | |
| < 1-5 years | 21 | 6.7 |
| 5-10 years | 43 | 13.7 |
| > 10 years | 250 | 79.6 |
| Specialty (n=309)* | | |
| General practitioner | 134 | 43.4 |
| Oral surgeon | 33 | 10.7 |
| Endodontic | 30 | 9.7 |
| Implant surgeon | 28 | 9.1 |
| Pediatric dentist | 22 | 7.1 |
| Orthodontist | 21 | 6.8 |
| Restorative Dentist | 12 | 3.9 |
| Prosthodontics | 15 | 4.9 |
| Periodontics | 9 | 2.9 |
| Other | 5 | 1.6 |
| Postgraduate qualification (n=315)* | | |
| None | 134 | 42.5 |
| Master's degree | 114 | 36.2 |
| University Diploma | 49 | 15.6 |
| PhD | 18 | 5.7 |
| Country where postgraduate qualification was obtained (n=169)* | | |
| Lebanon | 132 | 78.1 |
| Western Europe | 23 | 13.6 |
| Eastern Europe | 8 | 4.7 |
| USA | 5 | 3.0 |
| Egypt | 1 | 0.6 |
| Practice setting (n=322) | | |
| Private Clinic | 308 | 95.7 |
| Private Hospital | 1 | 0.3 |
| Public Hospital | 1 | 0.3 |
| Mixt | 12 | 3.7 |
| Continuing education source (n=314)* | | |
| None | 13 | 4.1 |
| National conferences | 154 | 49.0 |
| National and international conferences and continuing education lectures | 99 | 31.5 |
| International conferences | 33 | 10.5 |
| Continuing education lectures | 15 | 4.8 |
| Guidelines followed for prescribing prophylaxis regimens for infective endocarditis among susceptible patients (n=315)* | | |
| Do not know | 103 | 32.7 |
| Guidelines provided during dental qualification years | 84 | 26.7 |
| American Health Association (AHA) | 73 | 23.2 |
| Agence Française de Sécurité Sanitaire des Produits de Santé (Afssaps) | 33 | 10.5 |
| National Institute for Clinical Excellence (NICE) and the British Society for Antimicrobial Chemotherapy (BSAC) | 21 | 6.7 |
| Other | 1 | 0.3 |
| Attending at least 1 lecture relating to the use of antibiotics in dental medicine during the past 5 years (n=316)* | 154 | 48.7 |
| Reading at least 1 journal article relating to the use of antibiotics in dental medicine during the past 5 years (n=314)* | 157 | 50.0 |

| | Min | Max | Median | IQR | Mean | SD |
|---|---|---|---|---|---|---|
| Number of patients per week (n=233) | 10 | 240 | 48.00 | 30.00 | 53.71 | 35.81 |
| Number of prescribed systemic antibiotics courses per week (n=260) | 0 | 100 | 5.00 | 7.00 | 8.80 | 11.73 |
| Frequency of antibiotic prescription per dental consultation (%) (n=274) | 0 | 100 | 10.00 | 12.50 | 17.51 | 18.32 |

*Valid percentages are reported, Min: minimum; Max: maximum; IQR: interquartile range; SD: standard deviation

Table 2. Attitude of participating dentists toward antibiotic prescribing

| | | N | % |
|---|---|---|---|
| First choice antibiotic prescribed to patients allergic to penicillin (n=289)* | Spiramycin + Metronidazole | 86 | 29.8 |
| | Spiramycin | 69 | 23.9 |
| | Unspecified Macrolides | 35 | 12.1 |
| | Clindamycin | 34 | 11.8 |
| | Clarithromycin | 33 | 11.4 |
| | Amoxicillin | 11 | 3.8 |
| | Cephalosporin | 10 | 3.5 |
| | Amoxicillin + Clavulanic acid | 6 | 2.1 |
| | Metronidazole | 2 | 0.7 |
| | Cetirizine | 1 | 0.3 |
| | Ciprofloxacin | 1 | 0.3 |
| | Sulphamides + Diamonopyrimidine | 1 | 0.3 |
| First choice antibiotic prescribed to a pregnant woman (n=275)* | Amoxicillin + Clavulanic acid | 86 | 31.3 |
| | Spiramycin | 53 | 19.2 |
| | Amoxicillin | 44 | 16.0 |
| | Spiramycine + Metronidazole | 8 | 2.9 |
| | Clindamycin | 4 | 1.5 |
| | Azithromycin | 2 | 0.7 |
| | Cephalosporin | 2 | 0.7 |
| | Aminosides | 1 | 0.4 |
| | Penicillines or Spiramycine + Metronidazole | 1 | 0.4 |
| | Referral to gynecologist | 74 | 26.9 |
| First choice antibiotic prescribed to a breastfeeding woman (n=274)* | Amoxicillin + Clavulanic acid | 85 | 31.1 |
| | Spiramycin | 51 | 18.6 |
| | Amoxicillin | 42 | 15.3 |
| | Spiramycine + Metronidazole | 9 | 3.3 |
| | Clindamycin | 5 | 1.8 |
| | Cephalosporin | 2 | 0.7 |
| | Gentamycin | 1 | 0.4 |
| | Penicillines or Spiramycine + Metronidazole | 1 | 0.4 |
| | Referral to gynecologist | 78 | 28.5 |
| Frequency of referring cardiac patients to their physician when necessary (n=321)* | Always | 255 | 79.4 |
| | Sometimes | 58 | 18.1 |
| | Never | 8 | 2.5 |
| Enquire if the patient is currently taking an antibiotic before proceeding to consultation (n=320)* | Always | 278 | 86.9 |
| | Often | 24 | 7.5 |
| | Sometimes | 14 | 4.4 |
| | Never | 4 | 1.3 |
| Attitude regarding a patient who has already taken antibiotics before consultation (n=154)* | Continue antibiotic course | 85 | 55.2 |
| | Action depends on the antibiotic | 32 | 20.8 |
| | Change the antibiotic | 19 | 12.3 |
| | Action depends on time (change if antibiotic taken during last month) | 8 | 5.2 |
| | Discontinue antibiotic course | 7 | 4.5 |
| | Continue antibiotic course and add vitamins | 2 | 1.3 |
| | Increase the dose | 1 | 0.6 |
| Feeling pressure from patients to prescribe antibiotics (n=319)* | Always | 27 | 8.5 |
| | Often | 43 | 13.5 |
| | Sometimes | 72 | 22.6 |
| | Never | 177 | 55.0 |
| Factor(s) mostly influencing antibiotics prescribing behavior (n=321)*† | Previous antibiotic experience | 261 | 81.3 |
| | Comorbidities of the patient | 174 | 54.2 |
| | Socio-economic status of the patient | 103 | 32.1 |
| | Price of the antibiotic | 101 | 31.5 |
| | Samples availability | 44 | 13.7 |
| | Medical representative visits | 37 | 11.5 |

*Valid percentages are reported; †Percentages may add up to more than 100%, due to multiple possible answers

the consultation. Continuing antibiotic course was the dominant action when a patient was found to be already taking antibiotics (55.2%). Only 5.2% of dentists reported changing the antibiotic if given during the past month. Nearly half (45.0%) of participating dentists reported being, to varying extent, pressured by patients to prescribe antibiotics. Factors governing antibiotic prescribing were primarily physician-related (previous antibiotic experience: 81.3%), followed by patient-related factors (presence of comorbidities: 54.2%). It also should be noted that the socio-economic status (32.1%) and price of the antibiotic (31.5%) were approximately one third of the factors that influenced antibiotic prescribing behavior. Other less influencing factors were the availability of the samples and medical representatives (13.7% and 11.5%, respectively).

Table 3 describes prophylactic antibiotic prescription patterns of sampled dentists. The vast majority of dentists refrained from prescribing antibiotics for restoration (96.7%), prosthesis (96.4%), crown (93.8%) and local anesthesia (91.6%). Systematic antibiotic prescription was mostly considered for implant (55.7%), bone graft (48.3%) and surgical extraction (mandibular tooth: 46.9%, maxillary tooth: 47.1%). Prescription for patients at high risk for infection was more common for braces (33.3%) and scaling (28.2%). Great divergences were noted for bone graft, implant, teeth extraction and gerectomy. Conformity with evidence-practice guidelines was inconsistent; it was high for restoration and interim care (96.7% each), prosthesis (96.4%), crown (93.8%) and local anesthesia (91.6%), where antibiotics are not indicated. Agreement with guidelines was especially low for procedures where prophylactic antibiotics should be prescribed for high-risk patients, such as implant (2.6%), intraligamentary local anesthesia (4.2%), tumor resection (4.6%), frenectomy (8.8%), gingivectomy (9.2%) and Crown lengthening (10.4%). Among those who prescribed prophylactic antibiotics correctly when indicated, conformity with evidence-practice guidelines

Table 3. Prophylactic and Curative Antibiotic Prescribing Practices of Participating Dentists and Conformity with Evidence-Practice Guidelines

| N (%) | No | Yes all patients | Yes High-risk patients‡ | Indication | Conformity with evidence-practice guidelines* | | |
|---|---|---|---|---|---|---|---|
| | | | | | Type | Dose | Duration |
| | | | | | Among those who provided a correct answer to indication | | |
| **Reported prophylactic antibiotic prescribing*†** | | | | | | | |
| Bone graft (n=180) | 84 (46.7) | 87 (48.3) | 9 (5) | 87 (48.3) | 67 (77.0) | 54 (62.1) | 3 (3.4) |
| Braces (n=30) | 20 (66.7) | 0 (0) | 10 (33.3) | 20 (66.7) | NA | | |
| Crown (n=306) | 287 (93.8) | 0 (0) | 19 (6.2) | 287 (93.8) | NA | | |
| Crown lengthening (n=240) | 165 (68.8) | 50 (20.8) | 25 (10.4) | 25 (10.4) | 2 (8.0) | 1 (4.0) | 0 (0) |
| Extraction mandibular tooth (n=294) | 103 (35) | 138 (46.9) | 53 (18) | 138 (46.9) | 84 (60.9) | 38 (27.5) | 4 (2.9) |
| Extraction maxillary tooth (n=293) | 106 (36.2) | 138 (47.1) | 49 (16.7) | 138 (47.1) | 91 (65.9) | 49 (35.5) | 4 (2.9) |
| Flap surgery (n=166) | 101 (60.8) | 49 (29.5) | 16 (9.6) | 101 (60.8) | NA | | |
| Frenectomy (n=249) | 188 (75.5) | 39 (15.7) | 22 (8.8) | 22 (8.8) | 4 (18.2) | 2 (9.1) | 1 (4.5) |
| Germectomy (n=209) | 107 (51.2) | 80 (38.3) | 22 (10.5) | 80 (38.3) | 51 (63.8) | 26 (32.5) | 2 (2.5) |
| Gingivectomy (n=293) | 225 (76.8) | 41 (14) | 27 (9.2) | 27 (9.2) | 4 (14.8) | 2 (7.4) | 1 (3.7) |
| Implant (n=228) | 95 (41.7) | 127 (55.7) | 6 (2.6) | 6 (2.6) | 2 (33.3) | 1 (16.7) | 1 (16.7) |
| Interim care (n=306) | 296 (96.7) | 0 (0) | 10 (3.3) | 296 (96.7) | NA | | |
| Intraligamentary local anesthesia (n=311) | 298 (95.8) | 3 (1) | 13 (4.2) | 13 (4.2) | 2 (15.4) | 2 (15.4) | 0 (0) |
| Local anesthesia (n=311) | 285 (91.6) | 13 (4.2) | 13 (4.2) | 285 (91.6) | NA | | |
| Necrotic tooth (n=299) | 188 (62.9) | 84 (28.1) | 27 (9) | 188 (62.9) | NA | | |
| Prosthesis (n=306) | 295 (96.4) | 0 (0) | 11 (3.6) | 296 (96.4) | NA | | |
| Restoration (n=306) | 296 (96.7) | 0 (0) | 10 (3.3) | 296 (96.7) | NA | | |
| Scaling (n=309) | 215 (69.6) | 7 (2.3) | 87 (28.2) | 215 (69.6) | NA | | |
| *Simple extraction (n=305)* | 209 (68.5) | 46 (15.1) | 50 (16.4) | 50 (16.4) | 23 (46.0) | 17 (34.0) | 1 (2.0) |
| *Tumor resection (n=151)* | 126 (83.4) | 18 (11.9) | 7 (4.6) | 7 (4.6) | 0 (0) | 0 (0) | 0 (0) |
| **Reported curative antibiotic prescribing*‡** | | | | | | | |
| Agressive periodontitis (n=268) | 77 (28.7) | 176 (65.7) | 15 (5.6) | 176 (65.7) | 90 (51.1) | 47 (26.7) | 60 (34.1) |
| Apical abscess (n=306) | 97 (31.7) | 192 (62.7) | 17 (5.6) | 17 (5.6) | 9 (52.9) | 0 (0) | 1 (5.9) |
| Bacterial stomatitis (n=142) | 104 (73.2) | 38 (26.8) | 0 (0) | 38 (26.8) | 24 (63.2) | 21 (55.3) | 17 (44.7) |
| Cellulitis (n=253) | 53 (20.9) | 174 (68.8) | 26 (10.3) | 174 (68.8) | 122 (70.1) | 0 (0) | 67 (38.5) |
| Chronic periodontitis (n=289) | 213 (73.7) | 55 (19) | 21 (7.3) | 213 (73.7) | NA | | |
| Combined lesion (n=293) | 173 (59) | 117 (39.9) | 3 (1) | 173 (59) | NA | | |
| Fistula (n=285) | 137 (48.1) | 127 (44.6) | 21 (7.4) | 127 (44.6) | 77 (60.6) | 39 (30.7) | 58 (45.7) |
| Gingivitis (n=297) | 246 (82.8) | 37 (12.5) | 14 (4.7) | 246 (82.2) | NA | | |
| Maxillary sinusitis (n=159) | 104 (65.4) | 48 (30.2) | 7 (4.4) | 48 (30.3) | 36 (75.0) | 15 (31.3) | 18 (37.5) |
| Osteomyelitis (n=170) | 68 (40) | 90 (52.9) | 12 (7.1) | 90 (52.9) | 78 (86.7) | 61 (67.8) | 35 (38.9) |
| Periapical abscess (n=305) | 77 (25.2) | 203 (66.6) | 25 (8.2) | 25 (8.2) | 8 (32) | 0 (0) | 1 (4.0) |
| Periimplantitis (n=170) | 100 (58.8) | 51 (30) | 19 (11.2) | 19 (11.2) | 0 (0) | 0 (0) | 0 (0) |
| Periodontal abscess (n=284) | 75 (26.4) | 192 (67.6) | 17 (6) | 17 (6) | 8 (47.1) | 4 (23.5) | 4 (23.5) |
| Pulpitis (n=305) | 269 (88.2) | 27 (8.9) | 9 (3) | 269 (88.2) | NA | | |
| Salivary gland infection (n=136) | 113 (83.1) | 23 (16.9) | 0 (0) | 23 (16.9) | 20 (87) | 18 (78.3) | 9 (39.1) |
| Tooth decay (n=311) | 304 (97.7) | 5 (1.6) | 2 (0.6) | 304 (97.7) | NA | | |

NA: not applicable. †Dentists describing cases as referred or rarely seen were excluded; *Valid percentages are reported; ‡Selected patients with cardiac conditions; compromised immunity; shunts, indwelling vascular catheters, medical devices; and prosthetic joints (5-9).

| Table 4. Percentage of prophylactic antibiotics regimens for cardiac patients (n=103) | |
|---|---|
| types of prophylactic antibiotics | |
| Amoxicillin | 52.5 |
| Amoxicillin and Clavulanic acid | 36.4 |
| Unspecified penicillin | 6.1 |
| Spyramicin | 3.0 |
| Amoxicilin or Spyramicin | 1.0 |
| Depends on the case | 1.0 |
| doses of prophylactic antibiotics | |
| 2 g | 63.9 |
| 3 g | 9.8 |
| Flash dose | 8.2 |
| 50 mg/Kg | 4.9 |
| 1-2 g | 3.3 |
| 2-3 g | 3.3 |
| Other | 6.6 |
| timing of antibiotics prophylaxis | |
| 1 hour before procedure | 34.0 |
| 1 hour before and after procedure | 10.6 |
| 1 hour before and 6 hours after procedure | 7.4 |
| 1 hour before and 7 days after procedure | 6.4 |
| 2 hours before procedure | 6.4 |
| 1 day before procedure | 4.3 |
| 2 days before procedure | 3.2 |
| 3 days before procedure | 3.2 |
| Other | 24.5 |
| *Valid percentages are reported | |

regarding the type of antibiotics ranged between 0 and 77%; whereas that of dose ranged between 0 and 62.1%, and that of duration between 0 and 16.7%. Overall, there was a significant divergence from the guidelines for several indications for both patient who were and are not at risk.

Table 3 also shows curative antibiotic prescription patterns of participants; answers were inconsistent for the majority of conditions. Non-prescription was most common in case of tooth decay (97.7%), pulpitis (88.2%), salivary gland infection (83.1%) and gingivitis (82.8%). Around two-thirds of the dentists reported prescribing antibiotics for all cases diagnosed with cellulitis (68.8%), periodontal abscess (67.7%), periapical abscess (66.6%), aggressive periodontitis (65.7%) and apical abscess (62.7%). Discrepancies were mainly noted for fistula, aggressive periodontitis, apical abscess and maxillary sinusitis. It is important to note that 11.9% of respondents prescribe antibiotics for pulpitis and 17.8% of participants prescribe antibiotics for gingivitis, which is unnecessary prescribing. Also for conditions such as cellulitis (20.9%) and salivary gland infections (83.1%), there were a significant proportion of dentists for both conditions who do not prescribe antibiotics when they are actually indicated. The lowest conformities were observed for apical abscess (5.6%), periodontal abscess (6%) and periapical abscess (8.2%), where curative antibiotics are indicated only for high risk patients. Among dentists who provided a correct answer to indication, the prescribed types of antibiotics were adequate for cases with salivary gland infection (87%) and osteomyelitis (86.7%), and were all inadequate for periimplantitis. When curative antibiotics where prescribed correctly when indicated, conformity with evidence-practice guidelines regarding the type of antibiotics ranged between 0 and 87%; whereas that of dose ranged between 0 and 78.3%, and that of duration between 0 and 45.7%.

As displayed in Table 4, penicillins were the dominant type (95.0%) of prophylactic antibiotics for cardiac patients. Answers were greatly scattered, especially for the dose and timing. Doses ranged between 1.87g up to 5g, with 63.9% prescribing 2g. Timing of antibiotic prophylaxis ranged between 3 days before the procedure, up to 7 days afterwards. The most common timing was 1 hour before procedure (34.0%), followed by 1 hour before and after the procedure (10.6%).

| Table 5. Knowledge of antibiotic prescribing of participating dentists | | |
|---|---|---|
| | **N** | **%** |
| *Prophylactic prescription of antibiotics for cardiac conditions (correct answers)** | | |
| Prosthetic cardiac valves (n=140) | 135 | 96.4 |
| Rheumatic heart disease (n=131) | 26 | 19.8 |
| Mitral valve prolapsed with valvular regurgitation (n=124) | 16 | 12.9 |
| Previous infective endocarditis (n=127) | 102 | 80.3 |
| Previous coronary artery bypass graft surgery (n=140) | 70 | 50.0 |
| Hypertrophic cardiomyopathy (n=147) | 84 | 26.1 |
| Intravascular cardiac pacemakers (n=147) | 49 | 33.3 |
| Myocardial infarct in the last 6 months (n=125) | 26 | 20.8 |
| Cardiac transplantation recipients who develop cardiac valvulopathy (n=131) | 65 | 49.6 |
| Unrepaired cyanotic heart disease (n=134) | 57 | 42.5 |
| Recently placed coronary stents (n=144) | 30 | 20.8 |
| Atrial septal defect after 6 months of repair (n=134) | 59 | 44.0 |
| Ventricular septal defect with repair (n=140) | 56 | 40.0 |
| Patent ductus arteriosus (n=140) | 56 | 40.0 |
| Cardiac catheterization without stents (less than 1 year) (n=183) | 61 | 43.9 |
| *Prophylactic prescription of antibiotics for other conditions (in case of invasive procedure) (correct answers)** | | |
| Human immunodeficiency virus (n=155) | 90 | 58.1 |
| Neutropenia (n=132) | 51 | 38.6 |
| Cancer chemotherapy (n=136) | 81 | 59.6 |
| Diabetes (n=245) | 188 | 76.7 |
| Hematopoietic stem cell or solid organ transplantation (n=133) | 56 | 42.1 |
| Bisphosphonate therapy (n=173) | 62 | 35.8 |
| Chronic steroid usage (n=172) | 91 | 52.9 |
| Asplenism or status post splenectomy (n=175) | 69 | 39.4 |
| Patients with prosthetic joints (n=173) | 16 | 9.2 |
| *Valid percentages are reported | | |

Table 6. Mean Knowledge Scores (%) by Sociodemographic and Professional Characteristics

| | Prophylaxis for cardiac conditions (n=76) | Prophylaxis for non-cardiac conditions (n=85) | Side effects of antibiotics (n=322) |
|---|---|---|---|
| Overall score | 46.75 (14.82) | 39.21 (33.09) | 20.27 (18.77) |
| *Age in years* | | | |
| 24-34 | 53.33 (12.34) | 39.35 (35.13) | 23.80 (17.77) |
| 35-50 | 43.95 (15.27) | 43.46 (31.23) | 19.23 (18.46) |
| >50 | 45.83 (15.21) | 34.78 (33.55) | 19.95 (19.95) |
| p-value | 0.13 | 0.62 | 0.30 |
| *Gender* | | | |
| Male | 46.02 (15.35) | 40.50 (33.36) | 19.17 (18.65) |
| Female | 50.00 (12.19) | 35.74 (32.81) | 22.50 (18.90) |
| p-value | 0.36 | 0.55 | 0.13 |
| *Region* | | | |
| Beirut | 44.10 (7.47) | 23.14 (28.73) | 13.40 (10.97) |
| Other | 47.30 (15.91) | 45.53 (32.75) | 22.01 (19.92) |
| p-value | 0.27 | 0.003 | <0.001 |
| *Experience years* | | | |
| < 1-5 years | 56.19 (13.80) | 37.03 (41.94) | 25.85 (15.39) |
| 5-10 years | 47.33 (19.98) | 40.00 (32.74) | 21.26 (18.00) |
| > 10 years | 45.63 (13.89) | 39.65 (31.91) | 20.00 (19.28) |
| p-value | 0.20 | 0.97 | 0.38 |
| *Specialty* | | | |
| General practitioner | 47.13 (15.07) | 30.82 (31.65) | 20.25 (14.47) |
| Other | 46.26 (14.71) | 44.03 (33.22) | 20.28 (21.35) |
| p-value | 0.80 | 0.07 | 0.98 |
| *Undergraduate qualification* | | | |
| In Lebanon | 52.72 (13.37) | 45.89 (31.91) | 21.94 (19.87) |
| Outside Lebanon | 42.17 (14.38) | 32.73 (33.43) | 18.14 (16.89) |
| p-value | 0.002 | 0.07 | 0.06 |
| *Post-graduate qualification* | | | |
| No | 47.23 (15.07) | 30.82 (31.65) | 20.25 (14.47) |
| Yes | 46.45 (14.90) | 46.18 (32.91) | 20.59 (21.52) |
| p-value | 0.84 | 0.04 | 0.86 |
| *Continuing education* | | | |
| No | 46.66 (11.54) | 24.07 (32.52) | 18.68 (10.72) |
| Yes | 47.04 (15.26) | 43.07 (32.91) | 20.45 (19.09) |
| p-value | 0.96 | 0.17 | 0.58 |
| *Number of patients per week* | | | |
| 0-50 | 46.23 (18.13) | 44.14 (34.19) | 21.88 (19.98) |
| 51-100 | 49.16 (12.38) | 48.41 (31.60) | 27.60 (21.85) |
| >100 | 42.85 (14.32) | 68.88 (27.66) | 19.64 (11.51) |
| p-value | 0.67 | 0.29 | 0.13 |
| *Frequency of antibiotic prescription per dental consultation (%)* | | | |
| 0-10 | 45.71 (15.05) | 40.54 (34.36) | 21.36 (17.17) |
| >10 | 49.85 (16.43) | 41.58 (32.71) | 21.65 (20.82) |
| p-value | 0.30 | 0.89 | 0.90 |

Regarding cardiac conditions, the highest knowledge was for prosthetic cardiac valves (96.4%), followed by previous infective endocarditis (80.3%) (Table 5). The adequacy of answers greatly decreased for all other conditions. The worst knowledge was observed for mitral valve prolapsed with valvular regurgitation (12.9%) and rheumatic heart disease (19.8%). The mean score of dentists who provided answers to all questions in this section (n=76) was 46.75 (14.82). None of them had good knowledge about prophylactic prescription of antibiotics for cardiac conditions; two-thirds (67.1%) had poor knowledge, and one-third (32.9%) had intermediate knowledge. Regarding non-cardiac conditions, less than half of respondents could adequately identify prophylactic antibiotic prescription, except for the cases of diabetes (76.7%), cancer chemotherapy (59.6%), infection with the human immunodeficiency virus (58.1%) and chronic steroid usage (52.9%). Knowledge pertaining to prophylactic antibiotic prescription for patients with prosthetic joints was the worst (9.2%). For dentists who provided answers to all questions in this section (n=85), the average knowledge score was 39.21 (33.09). The participants had predominantly poor knowledge (67.1%); 14.1% had intermediate knowledge and only 18.8% showed good knowledge.

In total, 50.3% of sampled dentists could correctly identify at least one side effect of amoxicillin/co-amoxiclav. This rate sharply declined for other antibiotics, and was almost null for cephalosporin (3.7%). The mean knowledge score about side effects of antibiotics was 20.27 (18.77). Almost all dentists (97.5%) had poor knowledge; only 4 (1.2%) had intermediate knowledge and 4 others (1.2%) exhibited good knowledge.

As shown in Table 6, in the bivariate analysis, demographic and professional characteristics did not influence knowledge scores; with the exception of dentists in Beirut being less knowledgeable of prophylactic prescription for non-cardiac patients and antibiotic side effects than those working in other regions. Moreover, dentists receiving their

undergraduate qualification in Lebanon had greater knowledge scores about prophylactic prescription for cardiac patients than the others, and those with a post-graduate qualification had higher knowledge of prophylactic prescription for non-cardiac patients than their peers.

Finally, 75.9% of respondents were aware of the contribution of dentistry-based antibiotic prescribing to the problem of antibiotic resistance at the national level and 94.7% knew at least one cause of antibiotic resistance.

## DISCUSSION

Given the potential contribution of dentistry-based antibiotic misuse to the epidemic of antimicrobial resistance, this study was the first effort to describe current knowledge, attitude and practices related to antibiotics, and to assess the extent to which prophylactic and therapeutic prescribing conforms to guidelines among dentists across Lebanon. In order to reach the desired sample size (322 dentists), the survey targeted 1,530 dentists, of whom, 460 were accessible, revealing a participation rate of 21% out of all targeted dentists, and a response rate of 70% among those who were accessible. This is in line with previous similar national studies conducted among dentists in other countries.[13,17,28]

Although, within the population studied, the reported rate of antibiotic prescribing was relatively high (17.51%) compared to other studies in Australia, Belgium and the United Kingdom[12,29,30]; and while participants lacked uniformity in antibiotic prescribing knowledge and practices, unindicated, inappropriate and extended uses were obvious, suggesting guideline-incongruent prophylactic and therapeutic prescribing. The problematic prescribing in Lebanon is further evidence to the international concern of dentistry-based antibiotic misuse[11-17,28], and provides additional argumentation justifying the solicitation of national efforts to promote judicious antibiotic use across the profession. Several factors noted in our sample emerge as potential contributors to these findings, including poor knowledge of evidence-practice regimens, limited exposure to scientific updates relating to the use of antibiotics, in addition to pressure of non-medical factors, such as patient requests for antibiotics prescription and influence of pharmaceutical industry. Various non-clinical pressures are in agreement with studies from other countries.[11,12,31,32] Our sample exhibited several conform prescribing behaviors, such as mainly using macrolides as first-line antibiotics for patients allergic to penicillins.[33] This behavior was in line with data from Belgium[12], yet differed from data reported from other countries, where clindamycin and erythromycin were the most prescribed antibiotics in the United Arab Emirates and United Kingdom[13,15] and in Iran[16], respectively. Several factors might explain this finding, among them is the comparative safety and tolerance of macrolides and the concern from the higher rates of fatal and nonfatal adverse drug reactions associated with C. *difficile* infections with clindamycin use[34] in one hand, and the unavailability of erythromycin in oral form in Lebanon, on the other hand. Yet, several deviant practices related to this condition were observed, such as the use of penicillins for these patients, or even substituting antibiotics by anti-histaminic or even not recognizing that amoxicillin and amoxicillin/clavulanic acid are both from the penicillin group. These behaviors-denoting poor knowledge of basic antibiotic pharmacology-might engender serious side effects, some of which could be life-threatening. Similarly, as previously noted in Lebanon[35], the use of penicillins as primary antibiotics for pregnant and lactating women was evident. Yet, a substantial proportion of dentists adopted metronidazole as their first choice for these women. First-line use of this agent is not supported by evidence, especially during the first semester of gestation and during lactation, rather, it is typically indicated for second-line use.[34] Although few in numbers, alarming practices emerged in this patient population, such as the use of spiramycin, aminosides and gentamycin in first-line.

On the other hand, our sample showed evidence of factors fostering antimicrobial resistance. First, antibiotic prescribing was found to be biased toward broad spectrum agents, i.e. association amoxicillin with clavulanic acid, association spiramycin with metronidazole and metronidazole, which were used in numerous instances, even when not clinically required. This finding is universal among dental practitioners.[12,14,15,17,20] Second, a high proportion of dentists inquired whether the patient is using antibiotics before consultation; however the vast majority resorted to systematically changing the antibiotic to combat a potential or present infection and only few patients followed the recommendation of changing the antibiotic if taken in the previous month.[34] Third, massive doses ranging up to 5g and long duration extending to 8 days of prophylaxis were prescribed for cardiac patients-clearly exceeding the recommended dose and duration of use.[34] Fourth, a considerable proportion of physicians adopted routine prescription to all patients, even when not indicated, such as in flap surgery, implant and necrotic tooth; and this misuse was accentuated in antibiotic therapy, such as with cases diagnosed with combined lesion, periapical and periodontal abscess and periimplantitis. Additionally, among physicians who practiced indicated prescribing, optimal adherence to guidelines (type, dose and duration of antibiotic use) was practically inexistent in prophylaxis; it was slightly better for therapeutic use. It is worthy to note that most deficiencies revolved around over and extended use, rather than the type of antibiotics. Finally, the lowest conformity to guidelines was found where antibiotics are indicated for high risk patients only. Potentially, the practitioners might not be confident in identifying high risk patients requiring antibiotics, and resorted the routine prescribing as a preventive mechanism.

As found in other countries[15,16,35], knowledge related to conditions where prophylaxis is indicated varied widely amongst participating dentists, was on average far from being optimal, and showed to be specifically low when it comes to non-cardiac conditions. The high referral rate witnessed in our sample, might partially contribute to this finding in a vicious circle. Potentially, dentists are deferring providing care to at-risk patients due to deficiency in their medical knowledge - as noted among other physicians[36], thus losing motivation to continuously upgrade their knowledge and skills to take in charge these patients. In

parallel, knowledge about the side effects of antibiotic showed to be the poorest. Addressing this issue is of utmost importance, taking into account the fatal and nonfatal adverse reactions associated antibiotic use. We were able to identify few inconsistent factors associated with higher knowledge: practicing outside Beirut area, receiving their undergraduate qualification in Lebanon, and having a post-graduate qualification.

This study raises many questions to be explored in future endeavors. First, as found in previous publications[15,18,20], the majority of dentists were aware of the contribution of dentistry-based antibiotic prescribing to the problem of antibiotic resistance at the national level, and the vast majority of them acknowledged either over, extended and/or misuse of antibiotics as causes of antimicrobial resistance. It was noted that in our sample more importance was accorded to preventing and treating infections rather than preventing antimicrobial resistance. In fact, qualitative data from the United Kingdom indicate that while dentists are aware of the theoretical contribution of dentistry-based prescribing to the emergence of resistance, they perceive it to be far less incriminated than the contribution of their medical col¬leagues.[18] This might partly explain the conflicting results emanating from our study. Second, our sample exhibited high referral of pregnant and lactating women, as well as cardiac patients to specialist physicians, when antibiotic prescription is needed. This behavior possibly denotes the limited knowledge, capacity or time of participants to take in charge these critical conditions, or could be regarded as part of the multidisciplinary approach to patient care. Available data do not permit us to generate a conclusion. The study relied on self-reported practices and the answers were not verified against patient records. Participants might have provided more professionally desirable answers, probably resulting in an underestimation of the true prescribing levels. Future studies should consider auditing patient records to provide documented data and ensure accuracy. Another limitation of this study is the absence of published national treatment guidelines of antibiotics prescription in dental practice and the use of international guidelines to assess conformity which may have created some underestimation of the conformity. Moreover, telephone interviews may have underestimated the real percentage of antibiotic prescription. Finally, we used a systematic random sample which also limits the selection bias. In spite of this, the low response rate may affect the external validity.

## CONCLUSIONS

To conclude, while this study pioneers in revealing antibiotic-related knowledge, attitude and practices of dentists in Lebanon, following studies must further investigate the determinants of poor knowledge, attitudinal barriers and inappropriate prescribing, and future research is therefore required to identify practitioners most at-risk of prescribing antibiotics when they are unlikely to be of clinical benefit.

It is now vital that Lebanese professional dental bodies strengthen the knowledge of dentists, and support and encourage judicious antibiotic prophylactic and therapeutic antibiotic prescribing across the profession. Effective interventions could use pharmacist-delivered academic detailing[37] as well as clinical audit[38] with the issuing of national guidelines and an educational component[39], among others.

## CONFLICT OF INTEREST

All authors declare no conflict of interest.

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