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Antibiogram types of bacterial isolates from dental caries patients attending clinic at a teaching hospital in Nigeria

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Abstract

Around the world dental caries is amongst the commonest disease affecting all age groups and yet seen by all as less common and severe; especially among Africans. Worrisome, our recent study showed isolated dental caries bacteria to be resistant to available antibiotics. In this study, antibiogram typing of bacteria isolated from dental caries of patients attending the dental clinic at Irrua Specialist Teaching Hospital, Nigeria were investigated. The study involves 223 bacteria positive samples (*Streptococcus mutans* = 150; *Streptococcus sobrinus* = 36; *Lactobacillus acidophilus* = 22; *Streptococcus salivarius* = 10; *Streptococcus mitis* = 4) collected and screened against 24 antibiotics divided into 8 groups of 3 each. Antibiogram study was conducted using Ajumali's mnemonic coding and the results were presented in tables. The Ajumali's mnemonic coding showed that no two strains of *Streptococcus salivarius and Streptococcus mitis* were repeated. However, 18.8%, 43.71%, and 61.11% of *Lactobacillus acidophilus, Streptococcus mutans,* and *Streptococcus sobrinus* strain respectively presented repeated Ajumali's mnemonic codes. The "00000005, 02000005, 03010005, 01010005 and 63112005" mnemonic codes appear in both *S. mutans* and *S. sobrinus* isolates, "02000004" appears in both *L. acidophilus* and *S. mutans,* 03000005 appears in both *S. salivarius* and *S. mutans* and 03110005 in *S. mitis* and *S. sobrinus.* The repetition of mnemonic codes from *L. acidophilus, S. mutans,* and *S. sobrinus* isolates and the appearance of codes between isolates indicate that some isolates may have strains with phenotypical similarities.

Keywords: Antibiogram types; Bacterial isolates; Dental caries; Ajumali's mnemonic coding

1. Introduction

The oral cavity is usually within a certain temperature, moisture contains different nutritional compounds including carbohydrates, lipids, and proteins and shelters the growth of normal flora and some pathogenic bacteria [1, 2]. The growth and multiplication of bacteria colonizing the surface of teeth are the primary etiological agent of dental caries [3] and is recognized as one of the most infectious diseases worldwide [4, 5].

Actively growing bacterial colonies surrounding teeth area initiate the formation of biofilm by agglomerating into a long chain to form complex heterogeneous structures with the aid of their enzymes and excretory products [2]. The formed biofilm can resist different antibiotics, alcohol, and different bacteriocidal and bacteriostatic agents at a concentration of 10 to 100 times than that needed to destroy and is also exceptionally escape phagocytosis that helps to exist inside the host's oral cavity and makes it extremely difficult to kill [6]. These are the mechanisms that make the biofilm difficult to destroy when the therapeutic drugs are used in dental diseases [3].

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Dental caries usually demolishes the enamel and dentin by bacterial activity [7-10]. Globally, dental caries are a common chronic condition among people of all ages [11] and evidence has suggested linkage with overall health and utilization of dental care can cut down health care cost 12, 13]. It is now avowed that the formation of bacterial biofilm is responsible for a variety of human diseases such as osteomyelitis, middle ear infections, dental caries, medical instrument and device-related infections, native valve endocarditis, ocular implant infections, and chronic lung infections [14]. Despite this evidence of therapeutic resistivity, the commonest of dental caries as well as its links with other diseases, oral health remains optional for most populations. In addition, the antibiogram typing for bacteria isolate; especially for dental caries bacterial, has not been extensively studied. Yet it has long been documented that typing methods, like the bacteriophage typing of Staphylococcus aureus and Listeria monocytogenes [15, 16], serotyping of Salmonella spp. and Escherichia coli [17, 18], or biochemical typing of Enterobacteriaceae [19], have historically been important and contributed to the understanding of natural history and epidemiology of infections caused by strains of bacterial species [20]. It is therefore the aim of this study to analyze the antibiogram typing of bacterial isolates from dental caries isolates of patients attending a dental clinic in a teaching hospital in Nigeria using Ajumali's mnemonic coding method.

2. Material and methods

2.1. Study location and population

The study was carried out in Irrua Specialist Teaching Hospital (I.S.T.H), Irrua in Esan Central Local Government Area of Edo State, Nigeria which lies at Latitude 6.45^{o}N and Longitude 6.15^{o}E. This hospital is a tertiary health facility. The subjects included all patients attending the dental clinic in the Hospital.

2.2. Ethical approval

Ethical approval was obtained from the Health Research Ethics Committee of the Ambrose Alli University, Ekpoma (assigned number: 10/17 (001/17). The study was conducted according to the WMA declaration of Helsinki-Ethical principles for medical research involving human subjects.

2.3. Sample Collection and Processing

Three hundred and forty samples of suspected cases of dental caries were collected during the period of study. Following the recommendation of Dragica *et al.* [21], sterile dental forceps and sterile swab sticks, were used aseptically to collect samples, by scraping or swabbing the suspected caries lesion. All samples were cultured within 1 hour of collection in the Medical Microbiology Laboratory of Irrua Specialist Teaching Hospital. However, only 222 samples were positive for bacteria colonization and were analyzed.

2.4. Morphological and biochemical identification of isolates

The culture characteristics of isolated bacteria such as size, shape, hemolysis, pigmentation, and consistency were noted according to Cheesbrough [22]. The biochemical properties of the isolates were studied according to Bergey's Manual of Determinative Bacteriology.

2.5. Antibiotic Susceptibility Test

The susceptibility of the bacterial isolates to antibiotics were determined by single disc agar diffusion method as previously described by Cruikshank *et al*. [23] and Ochei and Kolhatkar [24] and 0.5 Mcfarland standard was used to standardize the inoculum to the density of bacterial suspension of 1.5 x 10^{8} (CFU/ml). Streptococci isolates were seeded on chocolate agar, while Lactobacilli species were seeded on Mueller Hinton agar for antimicrobial sensitivity testing. Furthermore, before the commencement of the experiment, control for the antibiotics was done against *Staphylococcus aureus* ATCC 25923 at 37°C for 24-48hours. The antimicrobial sensitivity plates were also controlled before usage by sterility test as described by Ochei and Kolhatkar [24].

The selection of antibiotics for this study was done by dividing 24 antibiotics into eight different groups of 3 antibiotics each per group, according to one or more of these criteria; mode of action, similarities, usage in the community, and generation of discovery as in Orhue et al [27]. In each group, 3 antibiotics were chosen, and were 2 antibiotics were available, another antibiotic that was odd to the group was used to complete the triplet arrangement. Each triplet antibiotics in each group were arranged in ascending order of their molecular weight viz;

2.5.1. Group 1

Ampicillin, Amoxicillin, and Imipenem. These are bacteria cell wall synthesis inhibitors. Imipenem has the advantage of being stable in the presence of β-lactamase (both penicillinase and cephalosporins) produced by many multiple drug-resistant Gram-negative bacteria. Ampicillin is a broad-spectrum aminopenicillin, while amoxicillin is a moderate spectrum, bacteriolytic, β-lactam antibiotic in the aminopenicillin family, and also it is better absorbed, following oral administration than other β -lactam antibiotics.

2.5.2. Group 2

Augmentin, Unasyn, and Flucloxacillin: Augmentin (amoxicillin/clavulanic acid) is a combination consisting of amoxicillin, a β-lactam antibiotic, and potassium clavulanate, a β-lactamase inhibitor. This combination results in an antibiotic with an increased spectrum of action and restored efficacy against amoxicillin–resistant bacteria that produce β–lactamase. Unasyn (ampicillin/sulbactam) is a combination of the common penicillin-derived antibiotic ampicillin and sulbactam, an inhibitor of bacterial beta-lactamase. The addition of sulbactam to ampicillin enhances the effects of ampicillin and is active against a wide range of bacterial. Flucloxacillin is a broad – spectrum with a fluorinated side chain, and it has activity against beta-lactamase-producing organisms such as *Staphylococcus aureus*.

2.5.3. Group 3

Chloramphenicol, Tetracycline, and Co-trimoxazole: Cotrimoxazole (Septrin) is a folic acid inhibitor while the other two are protein synthesis inhibitors. Here, they represent the most commonly used (abused) antimicrobials in the community.

2.5.4. Group 4

Erythromycin, Clarithromycin, and Azithromycin. These 3 antibiotics belong to the class of antibiotics called the Macrolides. They are inhibitors of protein synthesis and are bacteriostatic with a broad spectrum of activity against many Gram-positive bacteria such as *Streptococcus pneumonia* and few Gram-negative bacteria. Azithromycin and newer macrolides such as clarithromycin can be regarded as advanced generation macrolides compared with erythromycin.

2.5.5. Group 5

Gentamicin, Streptomycin, and Neomycin: These three aminoglycosides are broad-spectrum protein synthesis inhibitors, and they exhibit concentration-dependent bactericidal activity against most Gram-negative aerobic and facultative anaerobic bacilli, but not against Gram-negative anaerobes and most Gram-positive bacteria.

2.5.6. Group 6

Cephalexime, Cefuroxime, and Cefotaxime: These are cephalosporins class of antibiotics and together with cephamycins, they constitute a subgroup of β-lactam antibiotic called cephems. Cephalexin belongs to the 1st generation cephalosporins and is active predominantly against Gram-positive bacteria, and other generations have increased activity against Gram-negative bacteria, but often with reduced activity against Gram-positive bacteria. Cefuroxime and cefotaxime belong to the 2nd and 3rd generation cephalosporin respectively.

2.5.7. Group 7

Ciprofloxacin, Pefloxacin, and Ofloxacin. These three antibiotics belong to the Quinolones or Fluoroquinolone class of antibiotics. These three Quinolones act by inhibiting the DNA gyrase, and they have broad-spectrum activity.

2.5.8. Group 8

Metronidazole, Lincomycin, and Clindamycin. Metronidazole is anti-protozoan but is also active against anaerobic and facultative anaerobic bacteria. It inhibits nucleic acid synthesis by disrupting the DNA of microbial cells. Lincomycin and Clindamycin belong to the class of antibiotic known as the Lincosamides. Lincosamides prevent bacteria from replicating by interfering with the synthesis of proteins. Clindamycin is very active against anaerobes.

2.6. Antibiogram typing using Ajumali's Method of Pneumonic Coding

As can be seen on the result table, the sensitive result was scored as (+) while resistance was recorded as (-). The three antibiotics in each group were given numerical values of 1, 2, and 4. A perfect sensitivity to the three antibiotics will give a summation of 1+2+4 = 7. Complete resistance to the three antibiotics will give a summation of 0+0+0 = 0. Other

values are obtained by adding up these arbitrary numerical values; in which case an isolate can receive a score of 0 -7 in each triplet segment, together which then gives an eight-digit numerical value as the antibiogram type. NB: this is an adaptation of Ajumali`s method of pneumonic coding [25].

3. Results and discussion

The ability to quickly and reliably differentiate among related bacterial isolates is essential for epidemiological surveillance and is an endeavor as old as the discipline of bacteriology itself [20]. With the advance of molecular technology, typing methods with high versatility, type ability, reproducibility, and discrimination have been developed but they are never available in many hospitals because of the complex technology and costs for their implementation [26]. However, patterns of susceptibility to antimicrobial agents have been used widely for typing purposes, due to their ready availability, simplicity, and relatively cheap to carry out [26]. In the present study, 222 isolates of bacteria positive caries patients consisting of *Lactobacillus acidophilus* (n = 22), *Streptococcus salivarius* (n = 10), *Streptococcus mitis* (n = 4), *Streptococcus sobrinus* (n = 36) and *Streptococcus mutans* (n = 150) were examined. These isolates were screened against 24 antibiotics divided into 8 groups of 3 antibiotics and the antibiogram typing was determined using Ajumali's mnemonic coding as presented in tables 1 to 5. The Ajumali's mnemonic coding showed that no two strains of *Streptococcus salivarius* (table 2) and *Streptococcus mitis* (table 3) presented repeated code. This absence of duplicate code from *S. salivarius* and *S. mitis* appears to follow what Orhue et al. [27] reported for *Staphylococcus* spp (*Staphylococcus aureus, Streptococcus faecalis,* and *Staphylococcus saprophyticus*) in urine samples collected from suspected cases of urinary tract infections in the University of Benin Teaching Hospital, Nigeria. According to Orhue et al. [27], the absence of repeated code in *S. salivarius* and *S. mitis* makes each of the isolates phenotypically different from one another, even though they are of the same species and by implication, indicating a very higher resolving strain differentiation.

However, several strains of *Lactobacillus acidophilus* (table 1), *Streptococcus sobrinus* (table 4), and *Streptococcus mutans* (table 5a, b, and c) presented repeated codes. For *Lactobacillus acidophilus* (table 1) there were duplicates of repeated codes (01000004 and 02000004) resulting in 18.18% repeated codes. *Streptococcus sobrinus* (table 4) presented repeated codes of 61.11% with 03110005 and 01010005 repeated 4 times, 03010005 and 43112005 repeated 3 times and 63112005, 01000005, 02000005, and 03112005 duplicates. *Streptococcus mutans* (table 5a, b, and c) presented 43.71% repeated codes with 00000005 repeated 9 times, 03010005 and 23010005 repeated 5 times, 03000005, 02000005 and 63112005 repeated 4 times, 01010005, 02010004, 02010005, 22010005, 63110005 repeated 3 times and 10 duplicated codes. According to Orhue et al. [27], the presence of repeated codes in *L. acidophilus*, *S. sobrinus,* and *S. mutans* indicate that some of the isolates are phenotypically similar.

Figure 1 shows a set presentation of mnemonic codes appearing between isolated bacteria. Interestingly, the "02000004 mnemonic code" appears in both L. *acidophilus* and *S. mutans* while "00000005, 02000005, 03010005, 01010005 and 63112005" mnemonic codes appear in both *S. mutans* and *S. sobrinus* isolates, "02000004'' appears in both *L. acidophilus* and *S. mutans,* 03000005 appears in both *S. salivarius* and *S. mutans* and03110005 in *S. mitis* and *S. sobrinus.* Antibiogram typing has been used in clinical microbiology as a first-line method for identifying cases of bacterial cross-transmission [20] and to date still useful even if it has several practical limitations that makes it not suitable for comprehensive studies of bacterial population structure and dynamics, but very critical, endeavors of infection control and surveillance [28, 29].

Table 1 Sensitivity and antibiogram types of L. acidophilus isolated from dental caries cases in ISTH Irrua

Bacterial isolates	**Ampicillin**	**Amoxicillin**	**Imipenem**	**Augmentin**	**Unasyn**	**Flucloxacillin**	**Chloramphenicol**	**Tetracycline**	**Cotrimoxazole**	**Erythromycin**	**Clarithromycin**	**Azithromycin**	**Gentamycin**	**Streptomycin**	**Neomycin**	**Cephalexin**	**Cefuroxime**	**Cefotaxime**	**Ciprofloxacin**	**Pefloxacin**	**Ofloxacin**	**Metronidazole**	**Lincomycin**	**Clindamycin**	**TYPES**
	1	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	
1	-	-	-	+	+	-	+	+	-	+	-	-	+	-	-	-	-	+	-	-	-	+	-	+	03311405
2	-	-	-	+	+	-	-	-	-	+	-	-	+	+	-	-	-	+	-	-	-	-	-	+	03013404
3	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	01100004
4	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	02000004
5	-	-	-	+	+	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	+	03011004
6	-	-	-	+	+	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	07110005
7	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	02000004
8	-	-	-	+	+	-	+	+	-	+	-	-	+	+	-	-	-	+	-	-	-	-	-	+	03313404
9	-	-	-	+	+	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	+	+	03111006
10	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	00010004
11	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	01010004
12	-	-	-	+	+	-	+	-	-	+	-	-	+	+	-	-	-	+	-	-	-	+	-	+	03113405
13	-	-	-	+	+	+	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	+	07111004
14	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	02010001
15	-	-	-	+	+	-	+	+	-	+	-	-	+	+	-	-	-	+	-	-	-	+	+	+	03313407
16	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	01000004
17	-	-	-	+	+	-	+	+	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	+	03312004
18	-	-	-	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	+	03111004
19	-	-	-	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	+	03112004
20	-	-	-	+	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	+	01012004
21	-	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	+	03100406
22	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	01000004

Table 2 Sensitivity and antibiogram types of S. salivarius isolated from dental caries cases in ISTH Irrua

Bacterial isolates	**Ampicillin**	**Amoxicillin**	**Imipenem**	**Augmentin**	**Unasyn**	**Flucloxacillin**	**Chloramphenicol**	**Tetracycline**	**Cotrimoxazole**	**Erythromycin**	**Clarithromycin**	**Azithromycin**	**Gentamycin**	**Streptomycin**	**Neomycin**	**Cephalexin**	**Cefuroxime**	**Cefotaxime**	**Ciprofloxacin**	**Pefloxacin**	**Ofloxacin**	**Metronidazole**	**Lincomycin**	**Clindamycin**	**TYPES**
	1	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	
1	-	+	+	+	+	+	+	-	-	+	-	+	-	+	-	-	+	+	-	-	-	+	-	+	67152605
2	-	-	-	+	+	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-	-	+	-	+	03052005
3	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03010001
4	-	-	+	+	+	-	-	-	-	+	-	+	-	+	-	-	+	+	-	-	-	+	-	+	43052205
5	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03000005
6	-	+	+	+	+	+	+	-	-	+	-	+	-	+	-	+	+	+	-	-	-	+	-	+	67152705
7	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	02000001
8	-	-	-	+	+	-	+	-	-	+	-	+	-	+	-	+	-	-	-	-	-	+	-	+	03152105
9	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	02010001
10	-	-	+	+	+	-	+	-	-	+	-	+	-	+	-	-	+	+	-	-	-	+	-	+	43152605

Keys: - indicates resistance, + indicates sensitive.

Table 3 Sensitivity and antibiogram types of *S. mitis* isolated from dental caries cases in ISTH Irrua

Bacterial isolates	Ampicillin	Amoxicillin	Imipenem	Augmentin	Unasyn	Flucloxacillin	Chloramphenicol	Tetracycline	Cotrimoxazole	Erythromycin	Clarithromycin	Azithromycin	Gentamycin	Streptomycin	Neomycin	Cephalexin	Cefuroxime	Cefotaxime	Ciprofloxacin	Pefloxacin	Ofloxacin	Metronidazole	Lincomycin	Clindamycin	TYPES
	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	
1	-	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03100005
2	-	+	+	+	+	+	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	+	+	+	67010407
3	-	-	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03110005
4	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-		+	-	-	-	+	-	+	43000405

Keys: - indicates resistance, + indicates sensitive.

Table 4 Sensitivity and antibiogram types of S. sobrinus isolated from dental caries cases in ISTH Irrua

Bacterial isolates	Ampicillin	Amoxicillin	Imipenem	Augmentin	Unasyn	Flucloxacillin	Chloramphenicol	Tetracycline	Cotrimoxazole	Erythromycin	Clarithromycin	Azithromycin	Gentamycin	Streptomycin	Neomycin	Cephalexin	Cefuroxime	Cefotaxime	Ciprofloxacin	Pefloxacin	Ofloxacin	Metronidazole	Lincomycin	Clindamycin	TYPES
	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	
1	-	+	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	63112005
2	-	-	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03110005
3	-	+	+	+	+	+	+	-	-	+	-	+	-	+	-	-	-	-	-	-	-	+	-	+	67152005
4	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	01010005
5	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03010005
6	-	-	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	03012005
7	+	+	+	+	+	+	+	-	-	+	+	-	-	+	-	-	-	+	-	-	-	+	+	+	77132407

8	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	01010005
9	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	01010005
10	-	+	-	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	23112005
11	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	+	-	+	00000005
12	-	+	-	+	+	-	+	-	-	+		-	-	+	-	-	-	-	-	-	-	+	+	+	23112007
13	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	01010005
14	-	+	+	+	+	+	+	-	-	+	+	-	-	+	-	-	-	+	-	-	-	+	-	+	67132405
15	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	01000005
16	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	03010007
17	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	01000005
18	-	+	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	63112005
19	-	-	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03110005
20	-	-	-	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	03112005
21	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	+	+	+	03010407
22	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	02000005
23	-	-	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	43112005
24	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03010005
25	-	-	-	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	03112005
26	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	03010004
27	+	+	+	+	+	+	+	-	-	+	+	+	-	+	-	-	-	+	-	-	-	+	+	+	77172407
28	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	02000005
29	-	+	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03110005
30	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	01000004
31	-	-	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	43112005
32	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	02010005
33	-	-	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-		+	+	+	03110007
34	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03010005
35	-	-	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	43112005
36	-	-	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03110005

Table 5a Sensitivity and antibiogram types of *S. mutans* isolated from dental caries cases in ISTH Irrua

Bacterial isolates	**Ampicillin**	**Amoxicillin**	**Imipenem**	**Augmentin**	**Unasyn**	**Flucloxacillin**	**Chloramphenicol**	**Tetracycline**	**Cotrimoxazole**	**Erythromycin**	**Clarithromycin**	**Azithromycin**	**Gentamycin**	**Streptomycin**	**Neomycin**	**Cephalexin**	**Cefuroxime**	**Cefotaxime**	**Ciprofloxacin**	**Pefloxacin**	**Ofloxacin**	**Metronidazole**	**Lincomycin**	**Clindamycin**	**TYPES**
	1	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**	
1	-	+	+	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	61110005
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	00000005
3	+	+	+	+	+	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	77110005
4	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	+	-	-	-	+	-	+	00010605
5	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	77100005
6	-	-	-	+	+	-	-	-	-	+	+	+	-	+	-	-	-	-	-	+	-	+	+	+	03072027
7	-	-	-	-	+	-	-	-	-	+	-	-		-	-	-	-	-	-	-	-	+	-	+	02010005
8	-	+	+	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	63110005
9	-	-	-	-	+	-	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-	+	-	+	02012405
10	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	63000005
11	+	+	-	+	+	-	+	-	-	+	+	+	-	+	-	-	+	+	-	+	-	+	+	+	33172627
12	-	-	-	+	+	-	-	-	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-	+	03032004
13	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	01000005
14	-	-	-	-	+	-	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-	+	-	+	02130005
15	+	+	+	+	-	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	+	71052004
16	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	+	-	+	02010405
17	-	+	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	22010005
18	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	02000005
19	-	+	+	+	+	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	67110007
20	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	0200004
21	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	+	-	+	02042005

22	-	+	-	-	+	-	-	-	-	+	+	-	-	+	-	-	-	-	-	-	-	+	-	-	22032001
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	00000005
24	-	-	-	+	+	-	+	-	-	+	-	-	-	-	-	-	+	+	-	-	-	-	+	+	03110606
25	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	20010005
26	-	-	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	43100005
27	-	+	+	+	+	+	-	+	-	+	+	+	-	-	-	-	-	+	-	-	-	+	+	+	67270407
28	-	+	+	+	+	-	-	-	-	+	+	-	-	-	-	-	-	+	-	-	-	+	+	+	63030407
29	-	-	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	07100005
30	-	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	23010005
31	-	+	-	+	+	+	+	-	-	+	-	-	-	+	-	-	-	+	-	-	-	+	-	+	27112405
32	+	+	+	+	+	-	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-	+	+	+	73012407
33	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03010005
34	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	22000001
35	-	+	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	22010005
36	-	+	+	+	+	+	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	+	-	+	67010405
37	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	02000004
38	-	+	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	63112005
39	-	+	+	+	+	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	+	+	+	63040407
40	-	+	-	+	+	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	27010001
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	00000007
42	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	23000005
43	-	+	+	+	+	+	-	-	-	+	+	+	-	+	-	-	-	+	-	-	-	+	+	+	67072407
44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	00000005
45	-	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	23010001
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	00000005
47	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	02010004
48	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	23000004
49	-	+	-	+	-	-	+	-	-	+	-	-	-	-	-	-	+	+	-	-	-	+	+	+	21110607
50	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	02000005

Keys: - indicates resistance, + indicates sensitive.

Table 5b Sensitivity and antibiogram types of *S. mutans* isolated from dental caries cases in ISTH Irrua continue

Bacterial isolates	Ampicillin	Amoxicillin	Imipenem	Augmentin	Unasyn	Flucloxacillin	Chloramphenicol	Tetracycline	Cotrimoxazole	Erythromycin	Clarithromycin	Azithromycin	Gentamycin	Streptomycin	Neomycin	Cephalexin	Cefuroxime	Cefotaxime	Ciprofloxacin	Pefloxacin	Ofloxacin	Metronidazole	Lincomycin	Clindamycin	TYPES
	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	
51	-	+	+	+	+	-	+	-	-	+	+	-	-	+	-	-	-	-	-	-	-	+	-	+	63132005
52	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	03010001
53	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	00010005
54	+	+	+	+	+	-	+	+	-	+	-	-	-	+	-	-	-	+	-	-	-	+	+	+	73312407
55	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-		-	-	-	-	+	01010004
56	-	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	23010007
57	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	+	-	+	03010405
58	-	+	+	+	+	-	+	-	-	+	+	+	-	-	-	-	-	+	-	-	-	+	-	+	63170405
59	-	-	-	-	+	-	+	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	02340004
60	-	+	+	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	63010007
61	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	00010004
62	-	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	23010005
63	+	+	+	+	+	-	+	-	-	+	+	-	-	-	-	-	-	+	-	-	-	+	-	+	73130405
64	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	03000004
65	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	00010005
66	-	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	23010005
67	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	03000004
68	+	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	33010005
69	-	+	-	-	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	22110005
70	-	+	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	+	-	-	-	+	+	+	23110407
71	-	+	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	22010005
72	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03000005

73	-	+	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	22010004
74	-	-	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	03012005
75	+	+	-	+	+	-	+	-	-	+	+	-	-	-	-	-	-	+	-	-	-	+	+	+	33130407
76	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	02010005
77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	00000004
78	-	+	+	+	+	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	+	-	+	63010405
79	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	02010004
80	-	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	23010001
81	-	+	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	22010007
82	+	+	-	+	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	+	-	+	33030005
83	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03010005
84	-	+	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	+	-	-	-	+	+	+	23110407
85	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	03010004
86	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	20010005
87	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03000005
88	+	+	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	33110007
89	+	+	-	+	+	-	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-	+	+	+	33130007
90	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03010005
91	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	02000004
92	-	+	+	+	+	-	+	-	-	+	-	+	-	+	-	-	-	-	-	-	-	+	+	+	63152007
93	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	01010005
94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	00000005
95	-	+	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	63112005
96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	00000005
97	-	-	-	+	+	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	+	-	+	03070005
98	+	+	+	+	+	-	+	-	-	+	+	-	-	+	-	-	+	-	-	-	-	+	+	+	73132207
99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	00000005

Table 5c Sensitivity and antibiogram types of *S. mutans* isolated from dental caries cases in ISTH Irrua continue

Bacterial isolates	**Ampicillin**	**Amoxicillin**	**Imipenem**	**Augmentin**	**Unasyn**	**Flucloxacillin**	**Chloramphenicol**	**Tetracycline**	**Cotrimoxazole**	**Erythromycin**	**Clarithromycin**	**Azithromycin**	**Gentamycin**	**Streptomycin**	**Neomycin**	**Cephalexin**	**Cefuroxime**	**Cefotaxime**	**Ciprofloxacin**	**Pefloxacin**	**Ofloxacin**	**Metronidazole**	**Lincomycin**	**Clindamycin**	**TYPES**
	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	
100	-	+	+	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	63110005
101	-	+	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	23110005
102	-	-	-	-	-	-	-	-	-	+	+	+	-	+	-	-	-	+	-	-	-	+	-	+	00072405
103	-	+	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	62100005
104	-	+	-	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	+	23112004
105	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	02010005
106	+	+	+	+	+	+	+	-	-	+	+	+	-	+	-	-	+	+	-	-	-	-	+	+	77172606
107	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	02000005
108	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03010005
109	-	+	+	-	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	62012005
110	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03000005
111	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	02000005
112	-	+	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	+	+	63112007
113	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	02010004
114	-	+	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	23012005
115	+	+	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	+	+	73112007
116	-	-	-	-	+	-	-	-	-	+	+	+	-	-	-	-	-	+	-	-	-	+	+	+	02070407
117	-	+	-	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	23110005
118	-	+	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	63112005
119	-	-	-	+	+	-	+	-	-	+	-	+	-	+	-	-	-	+	-	-	-	+	-	+	03152405
120	-	+	+	+	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	63110005
121	-	+	-	+	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	21012005
122	-	+	-	+	+	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	27110005

123	+	+	+	+	+	+	+	-	-	+	-	+	-	+	-	-	+	-	-	-	-	+	+	+	77152207
124	-	-	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	+	03012004
125	-	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	23010005
126	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	01000004
127	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	60000005
128	-	+	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-		-	-	-	-	+	23012004
129	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	00000005
130	-	+	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	23012005
131	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	43000005
132	-	+	+	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	61110005
133	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03000005
134	+	+	+	+	+	+	+	-	-	+	+	-	-	-	-	-	+	-	-	-	-	+	-	+	77130205
135	-	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	23010004
136	-	+	-	+	+	-	+	-	-	+	+	+	-	+	-	-	-	-	-	+	-	+	+	+	23172027
137	-	+	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	+	20012004
138	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	03010005
139	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	01010004
140	-	+	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	63100005
141	-	+	+	+	+	+	+	-	-	+	+	-	-	+	-	-	-	-	-	-	-	+	-	+	67132005
142	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	20000005
143	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	01010005
144	+	+	+	+	+	-	+	-	-	+	-	+	-	+	-	-	+	-	-	-	-	+	-	+	73152205
145	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	00000005
146	-	+	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	23010005
147	-	+	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	+	63112005
148	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	01010005
149	-	+	-	+	+	-	-	-	-	+	-	+	-	+	-	-	+	-	-	-	-	+	-	+	23052005
150	-	+	+	+	+	-	+	-	-	+	-	+	-	-	-	-	+	-	-	+	-	+	+	+	63150227

Keys: - indicates resistance, + indicates sensitive.

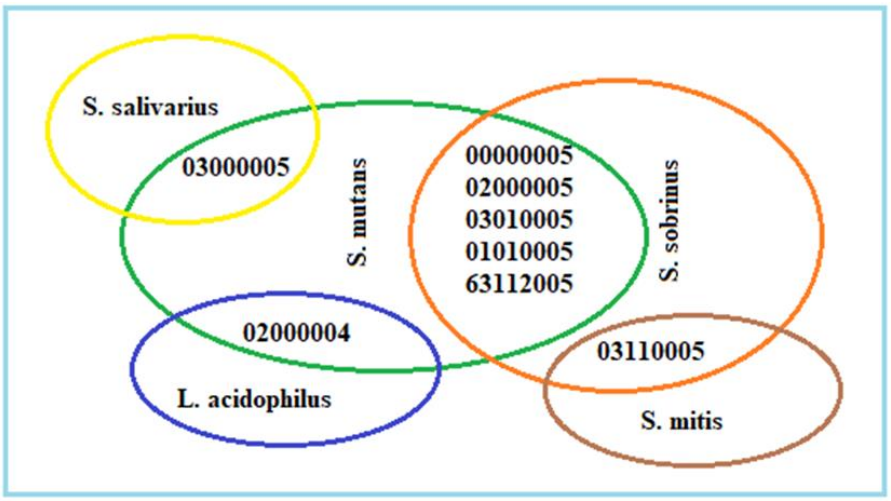

Figure 1 The appearance of mnemonic codes between isolated bacteria

In the present study, it was observed that S. mutans isolates share some coding similarities with *S. salivarius*, *S. sobrinus,* and *L. acidophils* while *S. sobrinus* and *S. mitis* also show a code similarity. In fact, *S. mutans* and *S. sobrinus* share about 5 phenotyping codes. The repetition of mnemonic codes within *L. acidophilus, S. mutans*, and *S. sobrinus* isolates and the appearance of codes between isolates indicate that some isolates may have strains with phenotypical similarities. Although in some cases it is a very useful prerequisite, it is generally accepted that phenotyping cannot usually stand-alone because the rate of genetic exchange within many bacterial species that a given phenotype may not always reflect evolutionary history [20]. Based on this assertion, two isolates that are phenotypically identical according to antibiogram typing might be discrete and vice vasa. For these reasons, over the past two decades phenotyping has been largely replaced by genotypic or 'molecular' typing [30-35].

4. Conclusion

Typing methods are used to study the spread and population dynamics of bacteria and other microorganisms in clinical and environmental settings, the antibiogram typing results of the present study showed that some dental caries bacteria might be phenotypically similar. While antibiogram typing using antibiotics susceptibility pattern may be simple, rapid, and readily available, and especially suitable for hospital laboratories with no sophisticated typing facilities, antibiogram typing with the present method can be used for bacteria surveillance, epidemiological analysis, and infection control purposes. We however recommend that other methods be carried out to investigate the reported phenotypic similarity between dental caries bacteria.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflicts of interest.

Statement of ethical approval

The study was approval by the Health Research Ethics Committee of the Ambrose Alli University, Ekpoma (assigned number: 10/17 (001/17).

Statement of informed consent

Informed consent form was duly signed and obtained from all study participants. The study was conducted following the WMA declaration of Helsinki-Ethical principles for medical research involving human subjects.

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