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Prevalence of Betahemolytic *Streptococci* other than Group A in a Tertiary Health Care Centre

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A B S T R A C T

The *Streptococci* are Gram-positive spherical bacteria (cocci) that characteristically form pairs and chains during growth. They are widely distributed in nature. Some are members of the normal human flora for e.g. commensal *Streptococci* of the oral cavity, are common causes of sub-acute bacterial endocarditis, others are associated with important human disease attributable in part to injection by *Streptococci*, in part to sensitization to them. Streptococcus species is uniformly susceptible to penicillin. But macrolides remains drug of choice for patient allergic to penicillin. Our aim was to study the prevalence of betahemolytic *Streptococci* and the antibiotic resistance pattern among the isolates causing various infections. A total of 366 positive cultures were taken from various samples of patients attending the Medicine and Paediatric outpatient department. Indiscriminate use of Macrolides for respiratory tract infection in the private practices has resulted in very high percentage of macrolide resistant among *Streptococci* in the population studied Increasing antimicrobial resistance is becoming a serious international problem in both hospital and community settings. Over the last several decades there has been increased resistance to Macrolides in several countries

Introduction

Beta hemolytic Group C *Streptococci* (GCS) account for about 5% of all cases of *Streptococcus* infection in adult human. These often look like Group A *Streptococci* on Blood Agar and are beta hemolytic *Streptococci* of this group are predominantly animal pathogens. The bacteria cause a condition known as "pharyngitis", an inflammation of the mucous membrane of the pharynx or throat which was formerly called Strep throat. The symptoms in humans can range in severity from very mild to incredibly severe. Aside from the sore throat, it can produce low to high fever, neck swelling, enlarged tonsils, and hoarseness and even acute to moderate nausea.

More severe symptoms included arthritis, pneumonia and even bacteremia all of which could lead to toxic shock (Ashton H Minty, Information on Beta Strep Group C)

On the other hand, Group G *Streptococci* (GGS) was identified in 1935 by Lancefield and Hare, as a part of normal flora of the pharynx, GIT, Genital tract and skin. And also it is present as commensal in throats of monkeys or dogs (CDC, Emerging infectious disease) It is usually not inhibited by Bacitracin. In recent years, GGS have been reported to cause a variety of human infections, such as, sore throat, pharyngitis, cellulitis, meningitis, infection of the heart

valves (endocarditis) and sepsis. Blood stream infection (bacteremia) due to GGS has been related to underlying conditions, such as alcoholism, diabetes mellitus, malignancy, intravenous substance abuse or breakdown of the skin. The spectrum of GGS infections ranged from mild skin and soft tissue infection (34 [46%]) to invasive diseases, including urogenital infection (7 [10%]); lower respiratory tract infection (7 [10%]); pharyngitis (6 [8%]); endocarditis and catheter infection (5 [7%]); and others (14 [19%]), such as peritonitis, pelvic abscess, rectal abscess, and septic arthritis. Four of the 6 persons with pharyngitis were assumed to be colonized with the organism. Eight (24%) of 34 skin and soft tissue infections were associated with bacteremia, 5 (15%) with osteomyelitis, and 20 (59%) with polymicrobial infections (San Wong**,** 2009).

Reported mortality rates for patients with GGS bacteremia also vary ranging from 5% to30% (Liao *et al.,* 2008). It is an important cause of endocarditis, septicaemia and septic arthritis.

Group C and Group G *Streptococci* have caused well documented epidemics of acute pharyngitis in children, but the importance of these organisms in causing endemic or sporadic pharyngitis is uncertain. The heterogenicity of GCS and GGS may obscure the role of certain subtypes, such as the large-colony-forming strains of group C (*Strep. dysgalactiae* subsp. *equisimilis*) or Group G in endemic pharynigitis (Zaoutis *et al.,* 2004).

They cause isolated exudative or common source epidemic pharyngitis and cellulitis, indistinguishable clinically from GAS disease (Arnold N Weinberg) Beta hemolytic GCS and GGs and hemolysin deficient variants cause epidemics of exudative pharyngitis pharyngotonsillitis (Gail William). Some strains contain fibrinolysin and streptolysins and infections can stimulate antistreptolysin O titres (ASO), similar to GAS.

Patients who are exposed to farm animals, zoo animals or unpasteurized milk products are at an increased risk for GCS or GGS, since they are inhabitants of horses, cows, swine's, sheep, goats and guinea pigs. Rapid diagnosis of pharyngeal carriage of GCS and GGS strains, that lead to glomerulonephritis, toxic-shock syndrome and Rheumatic fever, may prevent unnecessary death and disability (Williams, Gail)

The majority of GCS and GGS strains demonstrate *in vitro* susceptibility to penicillin's, vancomycin, erythromycin and cephalosporins. Antimicrobial tolerance, defined as minimum bactericidal concentration (MBC) 32 or more times higher than the MIC, among GCS and GGS has been reported for penicillin and other agents. Only a few clinical isolates have been reported to exhibit tolerance of vancomycin (Theoklis Zaoutis *et al*., 1999).

Different mechanisms of erythromycin resistance predominate in Group C and G *Streptococcus* isolates collected from 1992 to 1995 in Finland. Of the 21erythromycin resistant GCS and 32 erythromycin resistant GGS isolates, 95% had the mef A or mef E drug efflux gene and 94% had the erm TR methylase gene respectively (Janne Katraja, Helena Seppala *et al*., 1998).

According to the studies done in France, the Group A and G *Streptococci* were typically susceptible to penicillin G (MIC 0.003 to 0.5µg/ml) and relatively resistant (MIC 5 to 250µg/ml) to aminoglycoside antibiotics (naturally low-level resistance) (Thea Horodniceanu *et al.,* 1982). Penicillin resistance was not yet demonstrated in A, C or G, beta-hemolytic *Streptococci.* All beta-hemolytic Streptococci included in this study

were susceptible *in vitro* to penicillin, chloramphenicol and ceftriaxone in Argentina (Lopardo).

The factor most directly associated with the increase in antimicrobial resistance is the high level of antibiotic consumption among the population. Nonetheless the final cause of higher or lower prevalence of antimicrobial resistance depends on the circulatory clones (Emilio perez-Trallero *et al.*, 2007).

The main objective includes to study the prevalence of betahemolytic *Streptococci* causing various infections like respiratory and skin infections. To study the antibiotic resistance pattern among the isolates. And to detect the phenotypic pattern of Macrolide resistance by D-test.

Materials and Methods

A prospective study was under taken which included all age group attending general medicine OPD and Pediatric OPD of SRM Medical College Hospital from the month of March 2011-2012.Patients with symptoms of respiratory and pyogenic infection were included in study. Patients who were already on antibiotics were not included. Various samples like throat swab, Sputum, Blood, Pus, Tracheal aspirate, Bronchial wash, Bronchio-alveolar lavage etc. were collected with detailed case history. The samples were subjected to Gram staining, Gram positive cocci in short chains and pairs were observed in smear. They were then plated onto Blood agar plates-to observe haemolysis and Chocolate agar plates to observe bleaching and MacConkey agar plates.Basic biochemical tests for identification like Catalase, Bacitracin sensitivity, Pyrase test were performed for presumptive identification of beta hemolytic *Streptococci*, some Beta hemolytic colonies other than GAS also gave Bacitracin positivity. Further confirmation was done by performing latex slide agglutination grouping tests using kits (e.g.: Hi strep latex test kit from Hi Media)

Antibiotic susceptibility

Antibiotic susceptibility of the isolates was done by Kirby-Bauer method of disk diffusion using Blood agar plates adjusting the turbidity of the inoculum to McFarland 0.5 standard, the bacterial isolate was grown in Brain heart infusion broth and Todd-Hewitt broth. The antibiotic discs namely Bacitracin (0.04 units), Penicillin(10 units), Cephalothin (30 microgram) Clindamycin (2 microgram), Erythromycin (15 microgram), Cotrimoxazole (30 microgram), amoxyclav (20 and 10 microgram), ofloxacin, ceftriaxone (30 microgram), cefuroxime (30 microgram) were included to study the antibiotic pattern. Commercially available antibiotic discs were checked for quality using standard strains and then used for the test. Antimicrobial impregnated disks were placed on the Blood agar plates with the help of sterile forceps. Disks must be placed evenly with 24mm distance from center to center of each disk. Invert the plates and incubate them at 18-24 hours at 37^0 C with 10% carbon dioxide.

The plates are examined after overnight incubation. Zone of diameter is measured using calipers or a ruler. They were then compared with the NCCLS (CLSI) published guidelines.

Double disk diffusion test (D-test)

Testing of *Streptococcal* isolates with erythromycin and clindamycin disks applied closed together can often yield phenotypic information, although it is not always possible to differentiate between phenotypes using this method. D-test is performed for the detection of inducible clindamycin resistance. The *erm* genes encode resistance to the macrolides and lincosamides.

The gold standard for diagnosis of inducible resistance is the genotyping.

(CLSI Guide line, Wayne, pa: clinical and lab standard institute 2010)

The Clinical and Laboratory Standard Institute (CLSI) recommends disk diffusion or broth micro dilution testing for susceptibility testing of *Streptococci*.To ensure accurate results, laboratories should include a test for detection of inducible clindamycin resistance. The double disk diffusion method (D-zone test) is recommended for testing erythromycin resistant and clindamycin susceptible strain. A sterile cotton swab is dipped into a suspension of 18-24 hours growth of the organism in Todd-Hewitt or Brain Heart Infusion broth equal to a 0.5 McFarland turbidity standard within 15minutes of adjusting the turbidity at room temperature. The swab should be rotated several times and pressed firmly on the inside wall of the tube above the fluid level. Use the swab to inoculate the entire surface of a plate of Mueller-Hinton agar with 5% sheep blood.

After the plate is dry, use sterile forceps to place a clindamycin (2µg) disk and an erythromycin (15µg) disk 12mm apart for D-zone testing (Note - this differs from recommended 15-26mm for *Staphylococci* and a disk dispenser cannot be used to place disks on the plate for *Streptococci* testing (Paul H. Edelstein, 29 Apr, 2003) Incubate inoculated agar plate at 35˚C in 5% CO2 for 20-24 hours. Isolates with blunting of the inhibition zone around the clindamycin disk adjacent to the erythromycin disk (D-zone positive) should be considered to have inducible clindamycin resistance and are presumed to be resistant.

There are three types zone were seen in this. They are, iMLSB-the clindamycin zone is blunted towards the erythromycin because the erythromycin induces clindamycin resistance. cMLSB- No zone around either erythromycin or clindamycin because *erm* gene is fully expressed all times. M – type- no change in the clindamycin zone induced by erythromycin because *mef* does not pump out clindamycin regardless of erythromycin presence.

Results and Discussion

In our study, 366 positive cultures were taken from various samples; 49.63% were sputum, 36.3% were throat swab, 8.89% were pus, 2.59% were blood, 2.22% were tracheal aspirate, 0.37% was bronchial wash. A Total number of 297 Beta hemolytic *Streptococci* were isolated of which the rate of prevalence of GAS infection was the highest (41.41%) among the sample collected, followed by GGS (14.82%) and GCS (11.45%) (Table 1).

There is rise in GCS and GGS infection compared to prior studies and these results highlights the need to consider these as potential pathogen whenever isolated from cultures.

The rate of prevalence of Pneumococcal infections is also high (18.48%) compared to other study; of which 63.77% from sputum, 33.33% from throat swab, 1.45% from blood, 1.45% from tracheal aspirate.

Infection caused by GAS, GCS and GGS was seen more common in the age group of 45-60 years, whereas Pneumococcal infections were more in the age group of 15-30years.

The resistance pattern for other antibiotics in GAS were as follows, erythromycin 64%, penicillin 32.25%, clindamycin 27.05%, cotrimoxazole 94.26%, cephalothin 11%, amoxyclav 2.46%, ofloxacin 22.95%, ceftriaxone 1.67%, cefuroxime 2.46%.In GCS resistance were, erythromycin 41%, penicillin

44.12%, clindamycin 14.71%, cotrimoxazole 85.29%, cephalothin 23.53%, amoxycalv 0%, ofloxacin 32.35%, ceftriaxone 11.77%, cefuroxime 2.94%.In GGS antibiotic resistance pattern were, erythromycin 41%, penicillin 34.09%, clindamycin 18.18%, cotrimoxazole 97.73%, cephalothin 13.64%, amoxyclav 9.09%, ofloxacin 18.18%, ceftriaxone 4.55%, cefuroxime 2.27%. In *Pneumococci*, resistance was as follows: erythromycin 35.29%, penicillin 51.47%, clindamycin 7.35%, cotrimoxazole 92.65%, cephalothin 4.41%, amoxycalv 5.88%, ofloxacin 34%, ceftriaxone 5.88%, cefuroxime 8.82%.

In our studies the percentage of macrolide resistance among Beta Hemolytic *Streptococci* was 41.29% by MIC method. In GAS 64%, in GCS 41%, in GGS 41% by MIC method, this is alarming high as compared to the many of the earlier studies especially in India. It may be because of the difference in population included in the study, as this a hospital based study, where only positive samples were taken, rather than a community based study done by others.

According to our studies, in GCS, cMLS was 17.6%, M type was 82.35% In GGS, cMLS was 31.58%, iMLS was 10.53% and M type was 57.89% resistance pattern in GAS by D-test, cMLS was 27.85%, iMLS was 13.92%, M type was 55.69%.

The results of this study were similar to the finding by Thangam Menon, which showed higher rates of M type among macrolide resistant isolates. But this was opposite to the finding of Melo crustino who showed high percentage of cMLS. Our study also show a high level of iMLS, among GAS and GGS which was not reported in many of the earlier studies.

A study was conducted from March 2011-2012 at SRM Hospital Kattankulathur to study the prevalence of beta haemolytic *Streptococci* other than Group A causing various infections, like respiratory tract infections, Bacteremia, skin infections, etc., Antibiotic resistance pattern among the *Streptococcus* strains were also studied along with the phenotypic pattern of the macrolide resistance using D-test.

All positive cases of beta haemolytic *Streptococci Streptococci* other than Group A were included in this study. A detailed case history was collected for all the positive cases. Antibiotic resistance pattern of each isolate were detected.

Total samples collected was 366, 270 were positive, out of which 49.63% were sputum, 36.3% were throat swab, 8.89% were pus, 2.59% were blood, 2.22% were tracheal aspirate, 0.37% were bronchial wash. Out of 366 strains collected, Beta Hemolytic Streptococci (BHS) were 297(81.15%), which when serotyped with antisera, 123(41.41%) were positive with Group A antisera, 34 (11.45%) were positive with Group C antisera, and 44 (14.82%) with Group G antisera, others were non typeable.

Non typeable strains were (32.32%) not included in our studies. All alpha hemolytic *Streptococci* sensitive to Optochin were included as *Pneumococci*, which was 69(18.85%).

All the strains were stocked for further studies. Antibiotic Sensitivity tests (AST) were done for all isolates on Mueller Hinton agar with 5% sheep blood. All erythromycin intermediately sensitive and resistant strains were grouped as resistant strains and stocked for further study. A D test was done by using erythromycin (15µg) and clindamycin (2µg) disc kept at distance of 15mm apart to detect the phenotypes of macrolide resistance among the isolates of all beta hemolytic *Streptococcus* species.

Prevalence of macrolide resistance

The resistance pattern for GCS were as follows erythromycin 41%, penicillin 44.12%, clindamycin 14.71%, cotrimoxazole 85.29%, cephalothin 23.53%, amoxycalv 0%, ofloxacin 32.35%, ceftriaxone 11.77%, cefuroxime 2.94%.In GGS the resistance pattern were as follows erythromycin 41%, penicillin 34.09%, clindamycin 18.18%, cotrimoxazole 97.73%, cephalothin 13.64%, amoxyclav 9.09%, ofloxacin 18.18%, ceftriaxone 4.55%, cefuroxime 2.27%. Resistance pattern for GAS were as follows, erythromycin 64%, penicillin 32.25%, clindamycin 27.05%, cotrimoxazole 94.26%, cephalothin 11%, amoxyclav 2.46%, ofloxacin 22.95%, ceftriaxone 1.67%, cefuroxime 2.46%. In studies done in New York, 14 to 34% of S. *pyogenes* isolates were erythromycin-resistant, and 0% to 28% was clindamycin-resistant. None of the *s. pyogenes* isolates were resistant to Penicillin

Prevalence rate of macrolide resistance of *Streptococcus pyogenes* from various countries have been reported as 10% in Sweden, 17% in Finland and 22% in UK. Higher rates of resistance (>50%) has been reported in Taiwan, Japan and lower (2%) in Canada in Portugal 35.8%, Turkey 3.8% and Italy 38.3%. In South India, studies done by Menon *et al.,* showed 16.2% in 2007. It may be because of the difference in population included in the study, as this is a hospital based study, only positive samples were included, rather than a community based study done by others. In D test done to detect the Phenotypic pattern of the erythromycin resistance to detect cMLS, iMLS and M type, studies done by Melo Crustino 1999, in Portugal shows cMLS as 79.6%, M type as 16.7%. In studies done by Thangam Menon *et al.,* in 2006 the percentage of erythromycin resistance strain showed cMLS as 26.3%, M type as 73.6%. Our study we included both intermediate and resistance strain for typing, According to our studies resistance pattern in GAS, cMLS was 27.85%, iMLS was 13.92%, M type was 55.69%. In GCS, cMLS was 17.6%, M type was 82.35%. In GGS, cMLS was 31.58%, iMLS was 10.53% and M type was 57.89%.

Table.1 Distribution of positives in different samples

Specimen	GAS(123)	GCS(34)	GGS(44)	Pneumococci(69)
Throat swab	46(37.4%)	12(35.3%)	17(38.61%)	23(33.33%)
Sputum	54(43.9%)	16(47.06%)	20(45.45%)	44(63.77%)
Pus	15(12.2%)	4(11.76%)	5(11.36%)	0
Blood	4(3.25%)	2(5.88%)	0	1(1.45%)
Tracheal aspirate	4(3.25%)	0	1(2.27%)	1(1.45%)
Bronchial wash	0	0	1(2.27%)	0

Fig.1 A diagrammatic representation of the positive samples

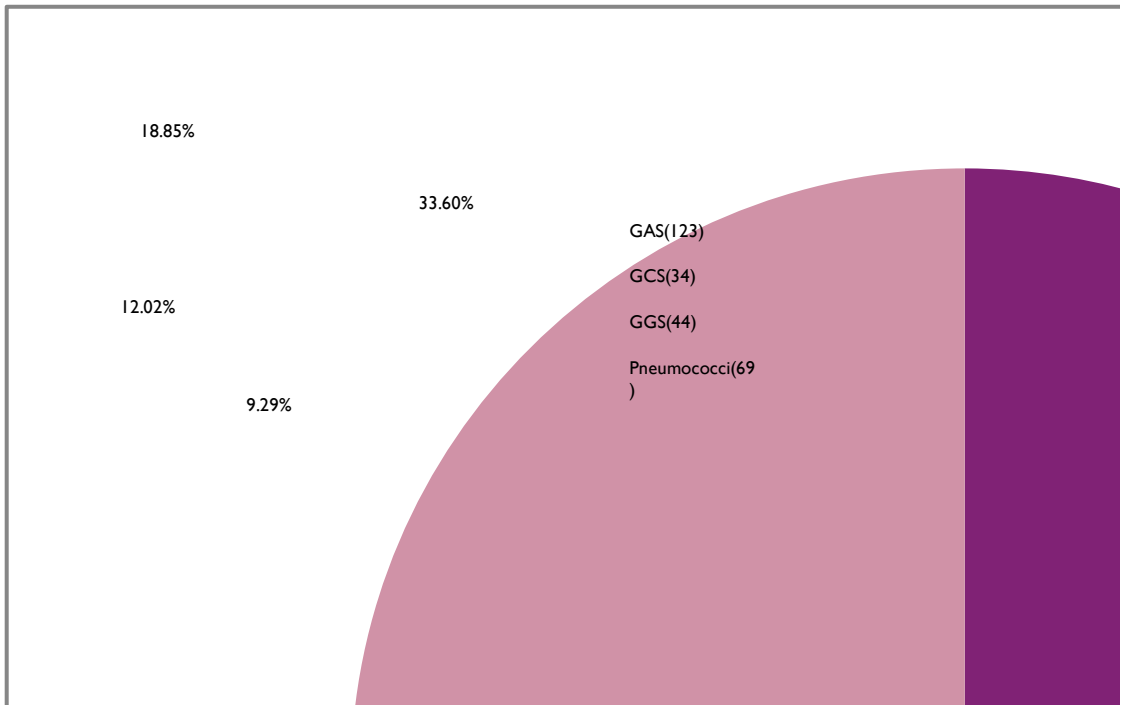


Fig.2 Graphical representation of Comparison of Age Sex ratio among total positive

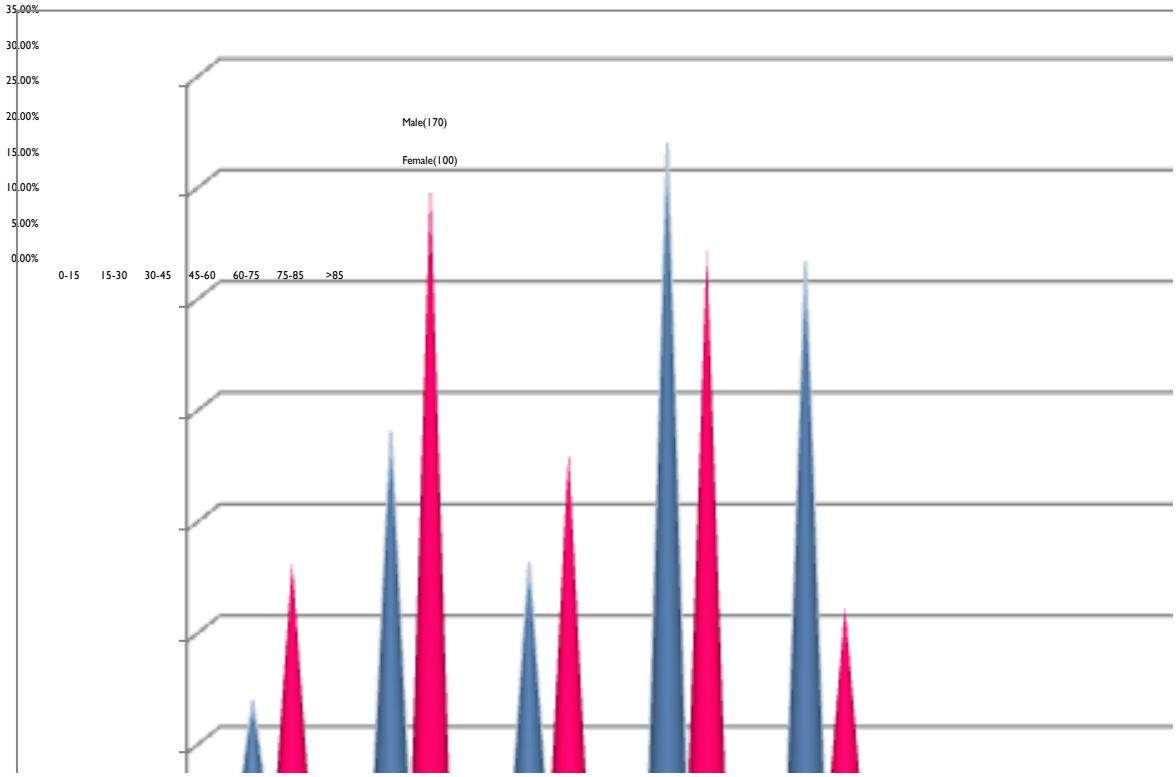


Fig.3 Graphical representation of Age wise distribution in *Streptococcus* species

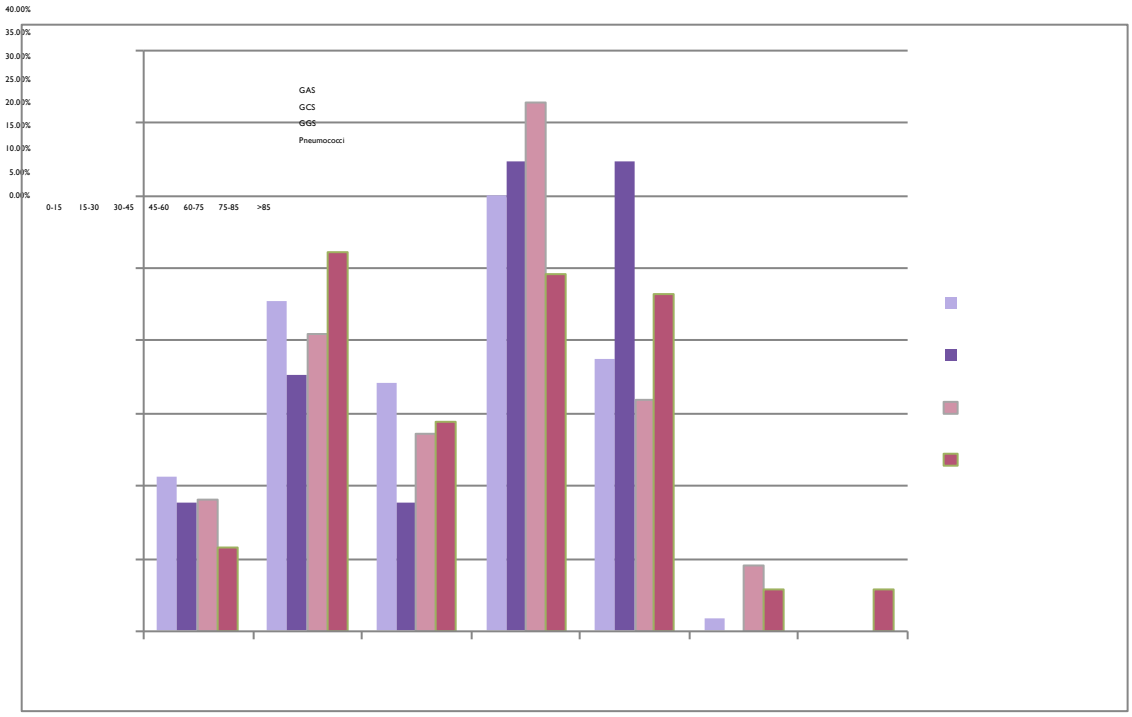


Fig.4 Resistance pattern in *Streptococcus* species

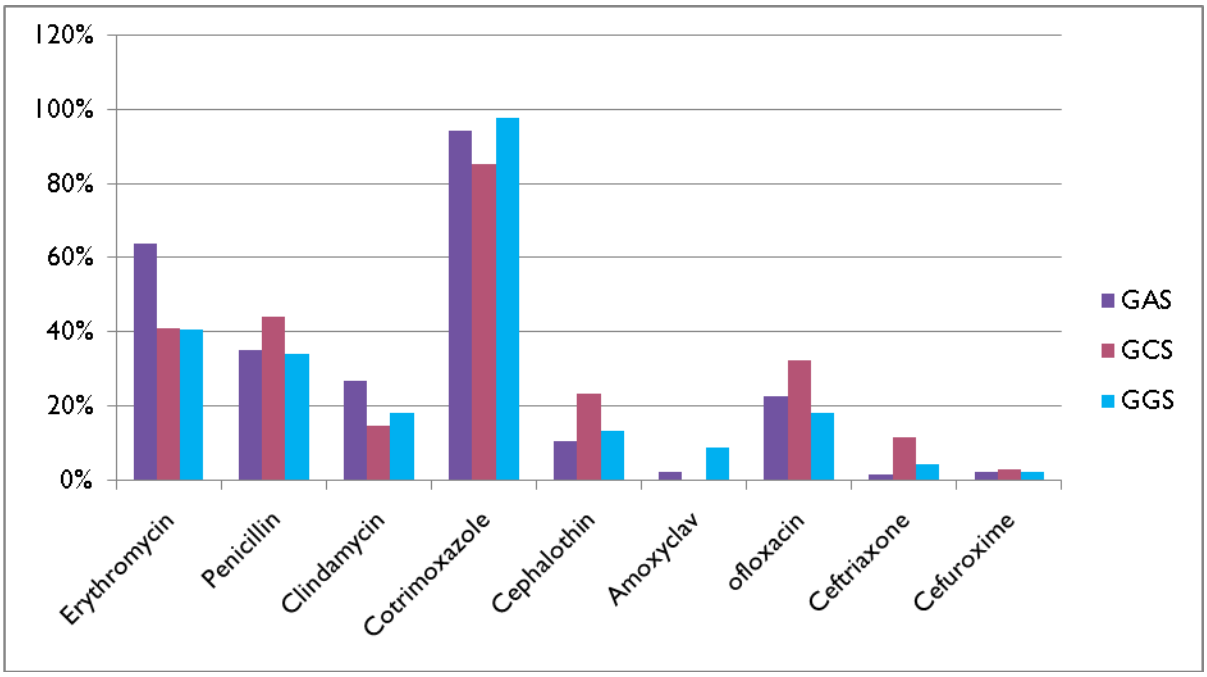
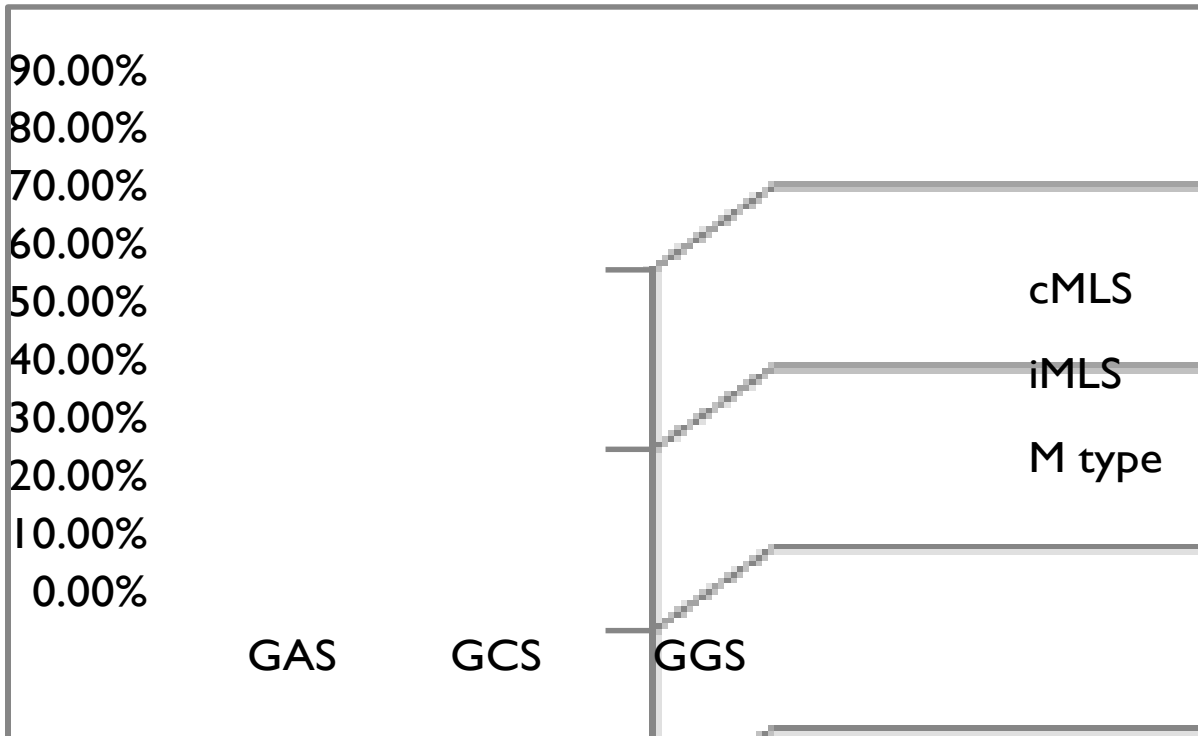


Fig.5 Resistance pattern in *Streptococcus* species (D test)



Our results were similar to the finding done by Thangam Menon, which showed higher rates of M type among Macrolide resistant isolates. But this was opposite to the finding of Melo crustino who showed high percentage of cMLS. Our study also show a high level of iMLS, among GAS and GGS which was not reported in many of the earlier studies.

In conclusion, thus according to our studies there is an alarming rise in GAS infection, which is of great concern. Macrolide resistances among the isolates are also higher compared to many studies. This can be explained by the over usage of macrolide for respiratory infections without proper antibiotic policies. The finding expand our knowledge of various *Streptococcal* infection in our population, GGS and GCS infections are on the rise which is justified, as the population studied was mostly communities living in villages closely associated with cattle and other pet animals. GAS infection are alarmingly high and Pneumococcal infections were also higher, compared to the other studies; therefore we need to insist on the importance of administration of pneumococcal vaccines wherever necessary.

Indiscriminate use of Macrolides for respiratory tract infection in the private practices has resulted in very high percentage of macrolide resistant among *Streptococci* in the population studied; compared to other studies. Therefore by this study we would like to highlight the necessity to do antibiotic sensitivity testing for all isolates, and limit the usage of antibiotics, whenever necessary and select the appropriate antibiotics for resistant strains.

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