Salmonella

Salmonella named after Salmon and smith

- Most important member of this genus is salmonella typhi observed by Eberth and Gaffky hence Eberth-Gaffky bacillus
- This genus creates important public health problems worldwide

Calssification and Nomenclature

- 1)Clinical classification-Oldest and user friendly composed of 2 groups
- a)Typhoidal salmonella-Includes salmonella typhi and paratyphi.Restricted to human hosts causes enteric fever(typhoid and paratyphoid fever
- b)Non typhoidal salmonella(NTS)-intestine of animals,reptiles,birds,insects.In humans causes gastroenteritis

2)Antigenic classification(Kauffmann-white scheme)

- Based on presence of different somatic(O) and flagellar (H) antigens
- -serogroups –based on O antigen salmonella are initially classified into serogroups named as 1,2,3 so on.Currently there are 67 serogroups each containing group specific O antigen

Eg serogroup 2 contains gr specific O ag type 2

Serotypes-Each serogroup is further differentiated into serotypes based on type of flagellar ag.more than 2500 serotypes present

3)Molecular class-

- Based on DNA hybridization studies genus Salmonella consists of 2 species S.enterica and S.bongori
- Within S..enterica there are 6 subspeciesenterica,salamae,arizonae,diarizonae,houtenae and indica
- Most of pathogenic typhoidal and NTS are placed under species enterica and subspecies enterica

Kauffmann – White scheme

- Serotype 0 antigens H antigens
 Phase 1
- Typhi 9,12,(Vi)
 Paratyphi A 1,2.12
 Paratyphi B 1,4,5,12
 Typhimuruim 1,4,5,12
 Enteritidis 1,9,12

1.2

1.7

1.2

а

a m

To describe nomenclature best is to mention genus followed by serotype for example Salmonella(Genus) typhi(serotype)

- Antigenic structure-
- 3 important antigens on cell wall
- O,H and Vi (surface envelope ag)

- O antigen-
- Part of cell wall lipopolysaccharide
- Heat and alcohol stable
- In Widal test O ag of S.typhi used
- Less immunogenic
- O ab appears early, disappears early and indicates recent infection
- O ag-ab forms chalky granular clumps
- Serogrouping based on O ag

H ag-

- Made of protien flagellin and confers motility Heat and alcohol labile
- In widal H ag of typhi, paratyphi a and b used
- More immunogenic
- Appears late, disappears late and indicates convalescent stage
- H ag ab reaction leads to large loose fluffy clumps
- Serogroups differentiated into serotypes based on H ag

Vi ag-

Capsular ag covering O ag

Expressed in few serotypes S.typhi and S.paratyphi C

When present renders bacilli inagglutinable by O antiserum

Poorly immunogenic and ab titers low, hence not helpful in diagnosis

Indicates development of carrier state

Vi ag used for vaccination

Antigenic variations-

- Variation of O ag:
- S-R variation-due to loss of O ag side chain from LPS
- Smooth colonies virulent
- S-R conversion due to mutation due to subculturing serially
- Lysogenic conversion-Bacteriophage infection converts s.anatum to newington

Variation of H ag-

OH-O variation: It is associated with loss of flagella induced by phenol agar and by mutation

Phase variation-Flagellar ag exists in 2 phases with each phase comprises of distinct set of flagellar ag

Phase 1 antigens are serotype specific designated as a,b,c etc and phase 2 ag are nonspecific and designated as 1,2 etc Serotypes can be classified as diphasic,monophasic or aphasic (S.gallinarum non motile)

For serotyping it is essential to identify ag of both phases

- At a time only one phase ag is expressed at a time and gets agglutinated by its phase antisera
- Phase conversion has been done to express other phase antigens
- Phase conversion is done in which a culture in phase 1 can be converted to phase 2 by passing through craiges tube caontaining specific phase 1 antiserum



Fig. 30.1: Craigie's tube demonstrating the reviving of the motile strains of *S*. Typhi 901

Typhoidal salmonella Includes S.typhi, S.paratyphi A, B and C Pathogenesis-Infective dose 1000-1000000 bacilli Risk factors-reduced stomach acidity, IBD Entry through epithelial M cells BME(Bacterial mediated endocytosis) by type III secretion system Entry into macrophages

Survival inside macrophages by bacilli regulatory system PhoP/PhoQ system mediates modification in LPS

- Salmonella in macrophages spread via lymphatics to enter blood
- Spread to reticuloendothelial tissues
- Secondary bacteremia

Clinical manifestations of Enteric fever

- Fever (step ladder pattern type of remittant fever)
- Headache ,chills,cough,sweating ,myalgia
- Rose spot rashes on trunk and chest 30% of cases at end of first week
- GI bleeding and nerological involvement

- Epidemiology-
- Humans only host for typhoidal salmonellae
- Mode of transmission
- High incidence in south east asia
- Common in urban areas ,young children and adolescents than adults

S.Typhi infection more common than S.paratyphiA,but paratyphi A appears to be increasing due to vaccination for typhi

10% of untreated patients become carriers and excrete bacilli in urine or feces Fecal carriers and urinary carriers Duration of shedding-**Convalescent 3wks to 3mths** Temporary carriers 3 mths to 1yr Chronic carriers> 1yr,more common in women, infants, old age, biliary tract abnormalities Lab diagnosis-Samples-Blood, bone marrow: 1 week serum(widal test), stool urine: 2,3 week Stool and urine:4 week Culture-Blood culture, clot culture Culture media-Monophasic medium containing BHI broth and castaneda biphasic medium both broth and agar

Procedure SPS(sodium polyanethol sulfonate) Incubation **Repeat subcultures** Colony appearance -NLF and NH Stool and urine culture-Remain positive even after antibiotic treatment and used for carriers detection

Urine –macconkey agar

Stool-enrichment broth and selective media like (SS agar-colourless colonies,DCA agar-NLF with black center,XLD-red colonies with black center,HEA-blue green with black center

Other specimens-bone marrow(when blood culture is negative),duodenal aspirate when blood and bone marrow negative Culture smear and motility **Biochemical testing** Slide agglutination test AST Widal test-Principle-Antigens used-4 ag used O ag of s.typhi(TO) H ag of s.typhi(TH0) H ag of paratyphi A and B(AH and BH)

Results

O agglutination appears as granular chalky clumps

H agglutination appears as loose cottony clumps Interpretation-

Highest dilution of sera at which agglutination occurs is taken as ab titer

Significant titer-H ab>200 and O ab>100(india)

False positive-

Anamnestic response, prior immunization

False negative-

Early stage ,late stage,carriers,those on antibiotics

Other ab detection tests-

Typhidot test, Typhidot M test, dot blot assay

Other tests-

- ELISA, CIEP, PCR
- Detection of carriers-culture,vi ab test,salmonella from sewage
- Typing-For surveillance and determining source of food borne infections and outbreaks in hospitals

Phage typing, biotyping, antibiogram typing

Treatment-

Ciprofloxacin, ceftriaxone, azithromycin

Drug resistance in typhoidal salmonella MDR S.typhi-resistance to Chloramphenicol, ampicillin and cotromoxazole Nalidixic acid resistance strains-due to increased use of flouroquinolones to treat MDR Ceftriaxone resistance-reported recently Now again old drugs are gaining popularity

Prophylaxis Control of cases Early diagnosis and treatment Disinfection of stool, urine soiled clothes by cresol, chlorine Follow up by stool and urine culture for carriers Control of carriers Detection of Vi antibodies, Ampicillin plus probenecid Surgery cholecystectomy plus ampicillin most effective Sanitation measures

Protection and purification of drinking water supplies

Food hygiene, hand washing and health education

Vaccine Indications Travelers going to endemic areas Household contacts People at increased risk Types of vaccinesa)Parenteral TAB vaccine-no longer used due to side effects

b)Parenteral Vi polysaccharide vaccine-

- Composed of Vi capsular purified polysaccharide ag fro S.typhi strain Ty2
- Single dose IM
- Protection for 2 years
- Age After 2 yrs of age

c)Typhoral(oral live attenuated S.typhi Ty2 1a vaccine

- This strain lacks enzyme UDP galactose epimerase
- Self destruction ,no pathogenesis
- After 6 yrs of age given
- Available as enteric coated capsules
- Immunity last 4 yrs with boosters recommended

Non Typhoidal salmonella(NTS)

Other than Salmonella typhi, paratyphiA, B, C

Majority by S.typhimurium, S.enteridis, newport, Dublin etc

NTS differs from typhoidal by being

a)Zoonotic

b)Transmitted by animal food whereas typhoidal by water

c)Common in rainy season coinciding with peak in food borne outbreaks

d)NTS common in developed countries where as typhoidal in developing countries
e)NTS outbreaks mostly in hospital where as Typhoidal are community based

Clinical features-

Gastroenteritis whereas in typhoidal it is uncommon

Bacteremia, meningitis, UTI, lung infections etc

Treatment

Conservative with fluid replacement

If drugs given ceftriaxone adnd ciprofloxacin only in invasive otherwise relapse and increase carrier rate

NTS more drug resistant than typhoidal

MDR strains resistant to more than 5 drugs

ACSSuT(ampicillin, chloram, strepto, sulfona, tetra)