Summary and Conclusions
SUMMARY AND CONCLUSIONS

The summary of the findings in the present study and conclusions drawn have been elucidated in the following sections.

SUMMARY

First Phase:

During a one year period (January 1998 to December 1998) the survey of 27,872 patients yielded 1596 cases of HAI giving an overall prevalence rate of 5.73% in an 860 bedded tertiary care hospital, Pondicherry.

Of the 1596 cases of HAI, urine, pus, wound swabs, sputum, throat swabs, endotracheal aspirate, blood and other samples were collected from 480, 440, 252, 193 and 231 cases of UTI, surgical wounds, pneumonia, bacteraemia and others respectively.

The median age of the population admitted in this hospital was 58 years, that of the patients with HAI was 63 years. Males predominated among the cases (56.9%). The prevalence of HAI was higher in younger age groups (<1 year, 11.5%) and in the elderly (>65 years, 8.4%).

The prevalence of HAI amongst surgical specialties was 6.2% and that of medical specialties was 4.8%. The most frequent site of HAI was urinary tract 30.1%, followed by surgical wounds 27.6%, lower respiratory tract infections 15.8%, bacteraemia 12.1% and others.

The predominant aerobic bacteria causing HAI were E.coli (20.5%), S.aureus (17.2%), P.aeruginosa (15.8%), K.pneumoniae (10.9%), E.faecalis (8.2%), S.epidermidis (6.3%), P.mirabilis (6.2%), E.cloacae (4%), A.baumannii (2.7%), K.oxytoca (1.8%) and others.
Staphylococcus and Escherichia together were the genera responsible for nearly half of all bacterial blood stream, urinary tract and wound infections and 35% of all the nosocomial pneumonia.

High levels of resistance was recorded against ampicillin and gentamicin (34% to 100%) by all Gram negative and Gram positive organisms. Cefotaxime and ciprofloxacin were more effective drugs compared to other antibiotics in use.

Continuous method of surveillance consumed more time (11 hr per 100 bed/week) than the laboratory based one (6.2 hr/100 bed/week). Microbiology laboratory based selective surveillance programme was found to be effective, less time consuming and suitable method of infection control programme in reducing HAI.

Second Phase:

In the 20 months period (January 1999 to August 2000), 1282 operations were complicated by 116 wound infections with an infection rate of 9.04% in one unit of general surgery department. Pus, wound swabs were collected from all 116 infected cases.

116 patients ranged in age from 23 years to 86 years (mean age ± SD = 57.95 ± 14.1; median age 60 years). Males predominated among the cases (62%).

The wound infection rate in the clean, clean contaminated, contaminated and dirty operations was 6.7%, 5.5%, 12% and 15.5% respectively.

The predominant aerobic bacteria causing nosocomial wound infections were *E.coli* (20.5%), *S.aureus* (17.2%), *P.aeruginosa* (15.8%), *K.pneumoniae* (10.9%), *E.faecalis* (8.2%), *S.epidermidis* (6.3%), *P.mirabilis* (6.2%), *E.cloacae* (4%), *A.baumannii* (2.7%), *K.oxytoca* (1.8%), *S.pyogenes* (0.5%) and others.
The predominant anaerobic bacteria isolated from postoperative wounds were Microaerophilic streptococci (40%), followed by Pept-streptococcus (20%), *B.fragilis* (20%), *Bacteroides melaninogenicus* (6.7%), Peptococci (6.7%) and *C.perfringens* (6.7%).

22% of the Microaerophilic streptococci, 20% of Peptostreptococci, 2% of Bacteriodes fragilis groups were resistant to metronidazole. 8%, 5% and 8% of *B.fragilis*, Peptococci and Microaerophilic streptococci were resistant to clindamycin respectively.

For *S.aureus* high levels of resistance was recorded against penicillin (100%), ampicillin (99%), erythromycin (62.5%), oxacillin (42%), methicillin (41.3%), ciprofloxacin (44.3%) and cefotaxime (45.6%). Vancomycin and gentamicin showed high levels of susceptibility 100% and 74.6% respectively.

*E.coli* showed high levels of resistance to chloramphenicol (61.5%). Gentamicin, ciprofloxacin, ceftazidime, cotrimoxazole, cefuroxime, amikacin and cefotaxime showed maximum levels of activity with susceptibility of 85.5%, 88%, 85%, 81.5%, 67.6%, 90% and 88% respectively.

*P.aeruginosa* showed high levels of resistance to cefotaxime (92.1%), cotrimoxazole (98.7%) and chloramphenicol (74.5%). Gentamicin, ciprofloxacin, ceftazidime and amikacin showed maximum levels of activity with susceptibility of 47%, 50%, 69.7% and 88% respectively.

Ten inanimate environments of 3 operation theatres were studied on 21 occasions. On different occasions, specimens obtained from OT floor, table, grill of the A/C, scrub tub, OT normal saline, IV fluid were found to contain different aerobic bacteria like *S.aureus*, Klebsiella spp, *P.aeruginosa*, *E.coli*, Acinetobacter, coagulase negative Staphylococci, Micrococci, diphtheroids. OT air was found to
grow coagulase negative Staphylococci on 11 occasions and S.aureus on 5 occasions.

Fifteen inanimate environments of general surgical wards and dressing room environments were studied on eight occasions. Ward air was positive for S.aureus on 26.7% of occasions and coagulase negative Staphylococci on 73.3% of occasions. On all occasions the ward bathroom floor was found to be contaminated with E.coli, P.aeruginosa, Klebsiella spp, Proteus spp, Streptococcus, coagulase negative Staphylococcus, Acinetobacter spp, Citrobacter spp. Patients' clothings and bedding were contaminated on 14 (77.78%) and 12 (66.67%) occasions.

Dressing room preparation tray, air, sink, floor, savlon, normal saline, cheatle forceps water were found to be contaminated with S.aureus, Coagulase negative Staphylococci, P.aeruginosa, Acinetobacter spp, diphtheroids and aerobic spore bearers.

A total of 348 samples were obtained from the 116 postoperative patient's nose, axilla and perinimum. Aerobic bacteria were isolated from all 348 samples collected from nose (116), axilla (116) and perineum (116) of these patients. 10 and 12 samples each were collected from surgeons, sisters and ancillary staff from nose, axilla and perineum. Nasal carrier rate was high in surgeons (66.7%), sisters (57.1%) and ancillary staff (58.3%) as compared to nasal carrier state (33.6%) in patients. Gram negative bacteria were isolated from nose, axilla and perinimum of surgeons, sisters, ancillary staff on 16.7%, 12.5% and 30% occasions, 14.3%, 12.5% and 25% occasions and 16.7%, 20% and 25% occasions respectively.

Total number of 90 isolates of E.coli (35), S.aureus (30), P.aeruginosa (25%) obtained from postoperative wound cases were correlated and compared with 5 E.coli, 20 S.aureus, 10 P.aeruginosa strains isolated from different areas in the environment (OT, ward and dressing room) and 5 E.coli, 26 S.aureus, 10 P.aeruginosa strains from normal flora of the patients and health care personnel.
Using different biochemical profiles, phenotypic identification of 45 \textit{E. coli}, 45 \textit{P. aeruginosa} and 80 \textit{S. aureus} isolates was carried out. 18, 21 and 24 different phenotypes were found for \textit{E. coli}, \textit{P. aeruginosa} and \textit{S. aureus} respectively.

Of the 80 \textit{S. aureus} strains subjected to phage typing with conventional set and MRSA set of phages, 13 strains (16.25\%) were typed by the conventional set and 20 (25\%) became typable by MRSA set of phages. Of the typable strains by conventional set 5 (6.25\%) belonged to Group II, 1 (1.25\%) each belonged to Group I and Group III respectively and 6 (7.5\%) to mixed group. When tested with MRSA phages, mixed phage groups (10) were found to be the most prevalent phage pattern followed by 30 / 33 / 38 (5 strains), 622 (4 strains) and M3 / M5 (1 strain).

Of the 45 strains of \textit{E. coli} subjected to 'O' typing 43 strains (95.6\%) were typable. Of the typable strains, 13 strains (28.8\%) belonged to 0101 serotype, 5 strains (11.1\%) to 01 serotype, 3 strains (6.7\%) to 0147, 2 strains (4.4\%) each to 098, 0106, 06, 08, 025, 020, 1 strain (2.2\%) each belonged to 068, 015, 0131, 0162, 0153, 050, 0167 and 081 serotypes respectively.

Plasmid profile analysis showed that all 45 \textit{E. coli} and 45 \textit{P. aeruginosa} isolates had definite plasmids, only 5 (6.25\%) of 80 \textit{S. aureus} isolates lacked plasmids entirely. An average of 2.47 to 4.02 plasmids per isolate was found with a range of 1-9 plasmids per isolate for \textit{S. aureus}, \textit{P. aeruginosa} and \textit{E. coli} strains. Different sizes of plasmids (0.85 Kb – 56 Kb) were found among these isolates.

Chromosomal DNA digests were obtained for \textit{S. aureus} (80), \textit{P. aeruginosa} (45) and \textit{E. coli} (45) isolates by using Hind III, Sal I, Bam HI / EcoRI respectively these enzymes produced well resolved patterns of bands.
In this investigation the present study found good correlation between biochemical profile (except for too many strains belonging to the same phenotype), phage typing, serotyping, PP analysis and REA of chromosomal DNA methods.

In the present study, auto infection was found to be the commonest mode of infection. The most common source being perineum, axilla and nares. Contaminated operation theatre air and ward bathroom floor were also found to be the sources of postoperative wound infection.

CONCLUSIONS

The prevalence rate of HAI in the 860 bedded JIPMER hospital was 5.73%. The predominant nosocomial infection was urinary tract infection followed by postoperative wound infection, lower respiratory tract infection and bacteremia.

The predominant pathogens causing the HAI were *E.coli*, *S.aureus*, *P.aeruginosa*, *K.pneumoniae*, *E.faecalis*, *S.epidermidis*, *P.mirabilis*, Enterobacter cloacae, *A.baumannii*, *K.oxytoca* and others. Multiple drug resistance was observed in almost all the nosocomial pathogens.

A microbiology laboratory based selective surveillance programme was found to be more effective, less time consuming and a more suitable method of infection control programme (ICP) in reducing HAI.

Aerobic bacteria were isolated in 99% of postoperative wound infection cases with *E.coli* 20.6%, *S.aureus* 17.7% and *P.aeruginosa* 14.7% being the commonest isolates. Phage typing of *S.aureus* isolates showed that phage group II was the predominant phage group. The predominant serotypes of *E.coli* causing wound infection were 0101, 01, 0147 and 025.

Anaerobes were isolated in 20.69% of wound infection cases with Microaerophilic streptococci (40%), *B.fragilis* (20%) and Peptostreptococcus (20%)
being the commonest isolates. No single case in this group yielded pure growth of anaerobic bacteria. All 24 cases (20.69%) were found to contain mixture of aerobes and anaerobes.

58% and 100% of S.aureus isolates were susceptible to methicillin and vancomycin respectively. Overall gram negative bacteria showed higher percentage of susceptibility to amikacin, ceftazidime and ofloxacin compared to other antibiotics tested.

Phenotypic methods like biochemical profile, phage typing, serotyping alone were not good enough to discriminate epidemiologically related isolates. However, strain differentiation was more accurate with additional genotypic methods such as PP analysis and REA. A corroboration of phenotypic and genotypic methods would be apt for any epidemiological investigation in our present setup.

Auto-infection was the most common mode of infection and the most common source being perineum, axilla and nares. Operation theatre air and ward bathroom floor were also found to be potential sources for postoperative wound infections in our surgical setup.