INTRODUCTION

Surgical site infection (SSI) is one of the most often post-operative complications and represents a notable burden in terms of patient morbidity and mortality [1]. SSIs usually occur at or near the incision area within 30 or 90 days, depending upon the procedure performed. SSIs are often localized to the incision site but can also extend into deeper adjacent structures [2].

Surgical antibiotic prophylaxis plays a major role in preventing occurrence of SSI after procedure. Appropriate antimicrobial agent (AMA) selection mainly depends on the pathogens most likely to cause an infection. Narrow-spectrum antibiotics are often used as pre-operative prophylactic agent because in which most organisms responsible for hospital-acquired infections are covered. The selection of antibiotic with the narrowest antibacterial spectrum is required to reduce the occurrence of multiresistant pathogens and also because broad-spectrum antibiotics may be required later if the patients develop series sepsis. Therefore, the use of ‘third generation’ cephalosporins such as ceftriaxone and cefotaxime should be avoided as surgical prophylaxis due to its lower efficacy in preventing SSI [3]. Cefazolin is considered as a primary choice of antibiotic for surgical prophylaxis due to its greater effectiveness toward methicillin-resistant Staphylococcus aureus and methicillin-susceptible S. aureus infection. In some cases, especially for surgery >4 h, redosing after 4 h is necessary to maintain the plasma drug concentration. In appendectomy/colorectal surgery, cefazolin+metronidazole is often added with cephalosporins to prevent the post-operative SSI. Apart from drug selection, timing also has importance. Surgical antimicrobial prophylaxis (SAP) must be started within 1 h before incision. In case of patients receiving vancomycin, it must be administered within 2 h before surgery. Prophylactic antibiotic should be discontinued within 24 h of surgery completion. However, in case of cardiothoracic surgery, it must be continued for 48 h [4].

METHODS

A prospective observational study was conducted in a surgical ward in all departments of a specialty hospital in Salem, Tamil Nadu, for a period of 6 months from February 2019 to July 2019. During the study period, patients who underwent surgery and met our inclusion criteria were conveniently selected, and the study population (178 patients) was calculated using Raosoft sample size calculator.

The baseline data collection was done by case sheet analysis, and further information was collected from either patient or their caretakers and recorded on data collection form which was previously prepared. The patient admitted for <3 days and those not willing to provide signed consent and patients who died or referred to higher centers were excluded from our study.

The data were collected in three parts. The first part includes patient demographic data (age, gender, and date of admission and discharge),
Table 1: Classification of antibiotics administered before surgery

| S. No. | Prophylactic antibiotic group | Prophylactic antibiotic | Administer as alone Frequency (n=204) | Percentage | Administer as combination Frequency (n=204) | Percentage |
|--------|-------------------------------|-------------------------|---------------------------------------|------------|---------------------------------------------|------------|
| 1.     | Cephalosporins                | Cefoperazone            | 47                                    | 23         | 10                                         | 5          |
|        |                               | Cefotaxime              | 25                                    | 12.2       | 9                                           | 4.4        |
|        |                               | Ceftriaxone             | 25                                    | 12.2       | 9                                           | 4.4        |
|        |                               | Cefuroxime              | 9                                     | 4.4        | 4                                           | 2          |
| 2.     | Penicillins                   | Amoxicillin             | 6                                     | 2.9        | 1                                           | 0.5        |
|        |                               | Piperacillin             | 11                                    | 5.4        | 3                                           | 1.5        |
| 3.     | Aminoglycosides               | Amikacin                | 6                                     | 2.9        | 1                                           | 0.5        |
|        |                               | Gentamycin              | -                                     | -          | 22                                          | 10.8       |
| 4.     | Nitroimidazoles               | Metronidazole           | 1                                     | 0.5        | 5                                           | 2.4        |
| 5.     | Fluoroquinolone               | Ofloxacin               | -                                     | -          | 2                                           | 1          |
|        |                               | -                        | -                                     | -          | 1                                           | 0.5        |
| 6.     | Carbapenems                   | Meropenem               | 2                                     | 1          | 2                                           | 1          |
|        |                               | Imipenem                | -                                     | -          | 2                                           | 1          |
| 7.     | Polypeptides                  | Colistin                | -                                     | -          | 1                                           | 0.5        |
| 8.     | Oxazolidinones                | Linezolid               | 1                                     | 0.5        | -                                           | -          |
| 9.     | Glycylcyclines                | Tigecycline             | -                                     | -          | 1                                           | 0.5        |
| Total  |                               |                         | 133                                   | 65         | 71                                          | 35         |
| Grand total (frequency) |                         |                         | 204                                   |            |                                             |            |

Table 2: Evaluation of prophylactic antibiotic administration

| S. No. | Prophylactic antibiotic | Frequency (n=178) | Percentage |
|--------|-------------------------|-------------------|------------|
| 1.     | Required and administered | 88                | 49.4       |
| 2.     | Required but not administered | 80            | 44.9       |
| 3.     | Not required but administered | 9               | 5.1        |
| 4.     | Not required and not administered | 1             | 0.6        |
| Total  |                         | 178              | 100        |

Table 3: Antibiotic administration pattern

| S. No. | Antibiotic administration | Frequency (n=435) | Percentage |
|--------|---------------------------|-------------------|------------|
| 1.     | Correct choice+correct dose+correct time+correct continuation | 10                | 2.3        |
| 2.     | Correct choice+correct dose+correct duration | 12               | 2.8        |
| 3.     | Correct choice+correct dose | 20              | 4.6        |
| 4.     | Correct choice of antibiotic | 21            | 4.8        |
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Vessal et al. [7], 2019, reported that prophylactic antibiotics were administered in 98% of the procedures, whereas only 68% of the surgeries required them according to guidelines. Vessel suggests that the surgeons in Iran are aware of the value of antibiotics in preventing SSI.

Another error noted was the omission of drugs in both pre- and postoperatively. About 30.3% of prescriptions omit both pre- and post-operative drug. Antibiotic administration pattern in surgeries required prophylaxis which demonstrates the prescribing pattern and prescribers’ knowledge about SAP prophylaxis.

Apart from 433 antibiotics, two more antibiotics administered to patients as intraoperative dose in a prolonged surgery of around 9 h. Only 2.3% of cases satisfy all the recommendations noted in guidelines, and rest shows abnormalities in either antibiotic selection, timing or dose of administration.

Vessal et al. [7] reported that only 7.5% were received correct drug with correct dose. Only 0.9% was prescribed according to guideline.

The intervention of this study is that majority of cases were non-compliance with guidelines in terms of drug selection, dose, and timing. The details regarding prescriber compliance to SAP guideline are shown in Table 4.

In this study, 94.3% were non-compliance with guideline due to lack of knowledge about prophylactic guidelines. Only 5.6% were prescribed according to guideline and satisfy all criteria mentioned in guidelines. In the Australian guideline, cefazolin is considered as the primary choice of cephalosporins for SAP. However, in our study, none of the patients were treated with respective drug. Ceftriaxone and cefoperazone were the most often drugs prescribed. About 55.1% of cefoperazone and 28% of ceftriaxone included in both pre- and post-operative prescription. Sixty participants were given ceftriaxone only as surgical prophylaxis, despite the fact that Australian guideline does not recommend it for any procedures. Ceftriaxone is a broad-spectrum antibiotic; therefore, its use as SAP would rise to the emergence of resistance and would either lead to a lack of response for any infections.

A study conducted in Ayder Referral hospital reported that the total compliance to SAP guidelines was 25%. Majority of the non-compliance was inappropriate SAP selection and extending the duration of antibiotic prophylaxis to more than 24 h. About 19.4% of procedures were non-compliant to SAP guideline in terms of indications.

Mousavi et al. [8] conducted an “audit of perioperative antimicrobial prophylaxis: compliance with international guideline” reported that in her study, only 22% of cases are under compliance with all recommendations.

| Table 4: Surgical prophylaxis compliance |
|------------------------------------------|
| S. No. | SAP compliance | Frequency (n=178) | Percentage |
|--------|----------------|-------------------|------------|
| 1.     | According to guideline | 10 | 5.6 |
| 2.     | Not according to guideline | 168 | 94.3 |
| Total  |                | 178 | 100 |

SAP: Surgical antimicrobial prophylaxis

| Table 5: Risk factor associated with SSI |
|-----------------------------------------|
| S. No. | Risk factors | Category | Number of patients (178) | Frequency of SSI (11) | Percentage |
|--------|--------------|----------|--------------------------|----------------------|------------|
| 1.     | Age          | 0–12     | 7                        | 0                    | 0          |
|        |              | 13–18    | 12                       | 1                    | 8.33       |
|        |              | 19–35    | 47                       | 2                    | 4.2        |
|        |              | 36–50    | 40                       | 2                    | 5          |
|        |              | 51–65    | 49                       | 4                    | 8.1        |
|        |              | 66–84    | 21                       | 2                    | 9.52       |
|        |              | ≥85       | 2                        | 0                    | 0          |
| 2.     | Gender       | Male     | 100                      | 7                    | 7          |
|        |              | Female   | 78                       | 4                    | 5.12       |
| 3.     | Comorbidity  | DM only  | 19                       | 4                    | 21.05      |
|        |              | HTN only | 8                        | 2                    | 25         |
|        |              | DM+HTN   | 24                       | 0                    | 0          |
|        |              | DM+HTN+Neuropathic fasciculitis, anemia | 3 | 0 | 0 |
|        |              | Miscellaneous | 11 | 0 | 0 |
|        |              | No-comorbidity | 113 | 5 | 4.42 |
| 4.     | Procedure    | Wound debridement and secondary suturing | 10 | 4 | 40 |
|        |              | CABG and post-CABG infection | 5 | 2 | 40 |
|        |              | TKR | 3 | 2 | 66.66 |
|        |              | Emergency LSCS | 18 | 1 | 5.55 |
|        |              | TAH | 15 | 1 | 6.66 |
|        |              | I and D | 4 | 1 | 25 |
| 5.     | Pre-operative | Antibiotics received | 162 | 9 | 5.55 |
|        |              | Not received | 16 | 2 | 12.5 |
| 6.     | Antiseptic wash | Povidone-iodine only | 154 | 9 | 5.84 |
|        |              | Povidone-iodine+NS | 13 | 1 | 7.69 |
|        |              | NS only | 7 | 1 | 14.28 |
| 7.     | Antibiotic administration | Inappropriate drug | 151 | 11 | 7.28 |
|        |              | Appropriate drug | 21 | 0 | 0 |
|        |              | Inappropriate dose | 57 | 6 | 10.52 |
|        |              | Appropriate dose | 115 | 5 | 4.34 |
|        |              | Inappropriate duration | 126 | 8 | 6.34 |

SSI: Surgical site infection, DM: Diabetes mellitus, HTN: Hypertension, CABG: Coronary artery bypass graft, TKR: Total knee replacement, LSCS: Lower segment cesarean section, NS: Normal saline, TAH: Total abdominal hysterectomy
Among the total population, around 11 patients had SSI due to inappropriate antibiotic selection, administration, and non-compliance to SAP guidelines. The risk factors associated with SSI are mentioned in Table 5.

The presence of comorbidity also had influence in SSI. About 25% of patients with SSI had HTN as comorbid condition. The highest rate of SSI was in the patients admitted for total knee replacement (66.66%). This was mainly due to inappropriate care and omission of pre-operative antibiotic drug. While considering drug administration, 11 cases with SSI were treated with inappropriate drug and majority with inappropriate duration and inappropriate dose. Hence, surgical antibiotic prophylaxis plays a major role in preventing the occurrence of SSI.

The study conducted by Ahmed et al. [9] mentioned that the rate of SSI is more in patients receiving post-operative antibiotics.

Limitations of the study
The key limitation of our study was difficult to explain about SAP importance and requirement because hospital authority was not ready to accept their fault. Post-discharge monitoring after the first review was not conducted by outpatient clinics, so the determination of SSI occurred after the first review was not done because SSI may emerge after 10 days. In some cases, patients were referred to other hospitals, so in that cases, completion of data collection was not possible.

CONCLUSION
The present study revealed that there is a poor compliance to the SAP guidelines followed in the respective hospital in terms of inappropriate antibiotic selection, inappropriate duration of antibiotic both pre- and post-operative, and prescribing of resistant drug. A total of 178 patients were observed in this study, of which 11 affected with SSI due to inappropriate antibiotic selection and in appropriate timing of drug administration and omission of pre-operative drug. This is mainly due to the unavailability of clinical pharmacist to assist physician in the selection and administration of the correct choice of prophylactic antibiotic according to the guideline. Another reason was that medical residents were not as fully trained on medication choices. Clinical pharmacist can solve these by providing proper counseling to the staff about SAP importance and its requirement in preventing SSI. In this study we followed the Australian guideline for surgical antibiotic prophylaxis because of unavailability of proper national or local SAP guideline. This study emphasizes that there is dire need to make local SAP guidelines and dissemination of that among all health-care workers to improve the antibiotic-prescribing pattern and patient safety by reducing the occurrence of SSI.

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AUTHORS’ CONTRIBUTION
Dr. N. Senthil Kumar: Manuscript review and statistical analysis.
Dr. K. Sivasakthi: Manuscript review, statistical analysis, and final review.
Ms. Jisa Elizabeth Joseph: Manuscript review, statistical analysis, and report preparation.
Mr. V. A. Vishnukumar: Concept, literature search, data collection, and manuscript preparation.
Mr. Geolin. R. P: Data collection, concept, and literature search.

CONFLICTS OF INTERESTS
Nothing to disclose.

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