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A Hospital-Based Prospective Study on Surgical Antimicrobial Prophylaxis and Incidence of Surgical Site Infections in the Department of General Surgery

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Abstract

Introduction: Health Care-Associated Infections (HAI) remain an important public health concern. Among the distinguished HAIs, Surgical Site Infections (SSL) contributes to significant increases of mortality and morbidity. Considerable prolongation in the length of hospitalization and added treatment expenses. Wound infections are the commonest hospital-acquired infections in surgical patients. Surgical site infection leads to increased hospital costs, prolonged hospital stays, compromised quality of life. Where appropriate antibiotics at the appropriate time lead to decreased postoperative infection. Moreover, this will reduce the misuse of antibiotics and antimicrobial resistance. Almost 30% to 50% of antibiotics in regular practice are used for prophylaxis before and after surgery. However, most of the antibiotics used in prophylaxis are not appropriate hence leading to resistance. Most of the time, the antibiotic is either given at the wrong time or continued for too long.

Aims and Objectives:

1. To evaluate the pattern of antimicrobial prophylaxis in general surgery.

2. To evaluate the frequency of post-operative infection.

3. To evaluate the prevalence of surgical site infection.

4. Finding and comparing frequency of risk factors, incidence of SSI, type of antibiotics used.

Results: 180 patients undergoing surgeries participated in the study. Majority of the prescriptions were of females (51.11%) compared to males (48.89%). The incidence of SSI was similar to both male (5.45%) and female (5%) in general surgery Staphylococcus aureus (52%) and Pseudomonas aeruginosa (15.79%) are found to be the most common microorganism causes SSI. Increased chances of infection were due to associated risk factors like DM, HTN, and Anemia eye. Patients with advanced age >50 years) were most susceptible to SS rather than younger age. Infected patients were treated with more than two numbers of antibiotics where none infected with single or double antibiotics. Hospital stays increase with incidences of SSI.

Conclusion: The study clearly concluded about the overuse and inappropriate choices of antibiotics. Hence, our study also suggests following the guidelines for rational use of antibiotics and minimizing the inappropriate antibiotic use is the best way to minimize the chances of SSI. The health centre needs to establish prophylactic antibiotics tenet which ought to be open and available by means of each member of the surgical team. The medical checklist needs to be practiced successfully. Frequent audit of prophylactic antibiotic use is wanted to enhance right practices. Surgeons must adhere to specific antibiotics guidelines.

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Introduction

health Care-related Infections is one of the principal public health challenge and among the distinguished HAIs, Surgical Site Infections (SSL) contributing to significant increases of mortality and morbidity, considerable prolongation in length of hospitalization and added treatment expenses [1,2]. Wound infections are one of commonest healthcare-associated infections in department of surgery. They bring about increased antibiotic usage, extended treatment costs and

hospitalization days. Multiple uses of antibiotic decrease the wound infection, however, excessive uses of antibiotics leads to antimicrobial resistance [3]. Surgical antibiotic prophylaxis is defined as the use of antibiotics to prevent infections at the surgical site [3]. It must be clearly identified from the use of antibiotics prior to the surgery and after the surgery to prevent infections.

First surgical antibiotics prophylactic experimented on pigs about 40 years ago. This experiment shows effective antibiotic therapy within three hours prior to surgery. After this several researches conducted on humans and animals, which show similar results on preventing infection after antibiotics therapy after prophylactic therapy [4]. Almost 30% to 50% of antibiotics in regular practice are used for prophylaxis before and after surgery. Proper use of antibiotics should be used as per guidelines. If not used proper according to the guidelines leading to resistance. Most of the time, the antibiotic is either given at the wrong time or continued for too long. Controversy stays as to the period of prophylaxis and additionally as to which precise surgical techniques ought to receive prophylaxis [5].

SSI Classification

According to the Centers for Disease Control and Prevention (CDC)'s guideline, SSIs are separated into three types, depending on the depth of infection penetration into the wound [6-8] (Figure 1 and 2).

There are 3 types of SSI

1. Superficial incisional infection

Superficial incision infection defined as a surgical site infection that occurs within 30 days of surgery and involves only the skin or subcutaneous tissue of the incision, and meets at least one of the following criteria:

• Purulent drainage from the site of incision.

• Organisms isolated from an aseptically obtained culture of fluid or tissue.

• At least one of the following signs or symptoms of infection - pain or tenderness, localized swelling, redness or heat.

2. Deep incisional surgical site infections

Deep incision surgical site infections must meet the following three criteria: It occurs within 30 days of procedure or one year in the case of implants and this involves deep soft tissues, such as the fascia and muscles.

Besides deep incision surgical site infections may involve any of the following criteria:

• Purulent drainage from the incision but not from the organ/space of the surgical site.

• A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms - fever (>38°C), localized pain or tenderness - unless the culture is negative.

• An abscess or other evidence of infection involving the incision is found on direct examination or by histopathology or radiological examination.

• Diagnosis of a deep incision SSI by a surgeon.

Organ/Space SSI

In Organ/Space SSI occurs within 30 days after the operation if no implant is left in place.

Sources of Infection

Sources of infection are primarily from a community or endogenous source [11].

Endogenous factors or sources of bacteria:

• Co-existing infection in other site of body.

• Skin.

• Bowel.

• Nature and site of operation (Clean, Clean-contaminated, contaminated, and dirty).

Exogenous factors or sources of bacteria:

• Operating team–related – Comportment; Use of impermeable drapes and gowns; Surgical scrub.

• Operating room–related - Traffic control; Cleaning; Air Surgical wound infections are also strongly influenced by the risk factors related to patients - extremities of age, obesity, diabetes mellitus, smoking habit, Coexisting infection at other site etc.

Etiological agents

Etiological agents commonly are bacteria, viruses, fungi and parasites. Infections can be obtained from one to another individual within the health facility (cross-contamination) or may be caused by the affected person's own flora (endogenous contamination). A few organisms may be acquired from recently infected inanimate items from another human source (environmental contamination). According to data collected from National Nosocomial Infection Surveillance System, most common SSIs is caused by *Staphylococcus aureus*, *Coagulase-negative Staphylococci* (CoNS), *Enterococcus* spp. And *Escherichia coli* remain the most frequently isolated pathogens during the study [8]. Additionally, nosocomial blood infections are frequently caused by Gram-positive organisms including *Coagulase-negative Staphylococcus*, *Staphylococcus aureus*, *Enterococci* 13, 14 and these microorganisms nearly always represent true bacteremias such as *E. coli* and other members of the *Enterobacteriaceae*, *Pseudomonas aeruginosa*, and *Streptococcus pyogens*.

Table 1: Risk factors.

Age	Antimicrobial prophylaxis	Skin antisepsis
Nutritional status	Colonization with microorganisms	Preoperative shaving
Diabetes	Altered immune response	Duration of operation
Smoking	Length of preoperative stay	Coexistent infections at a remote body site
Obesity Inadequate sterilization of instruments	Duration of surgical scrub Foreign material in the surgical site	Operating room ventilation Poor hemostasis
Surgical technique	Tissue trauma	Preoperative skin prep

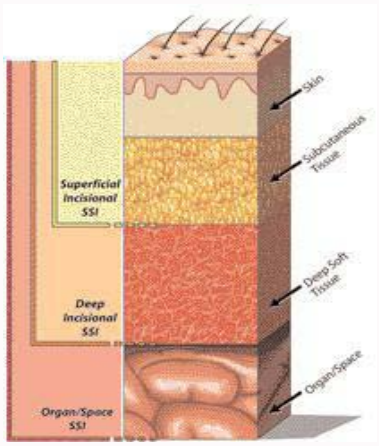

Figure 1: Types of SSI relating to infection penetration depth [9].

Risk factors: Shown in Table 1.

Prophylactic antibiotics

Prophylactic antibiotics lower the chance of infection and constitute vital components of most beneficial control to prevent infection to the surgical patient. So errors in antimicrobial prophylaxis for patient undergone surgery are one of the most frequent types of medication errors in hospitals. The antibiotics selected for prophylaxis must cover the expected pathogens responsible for the infection, should achieve adequate tissue levels during operation, cause minimal side effects and be relatively inexpensive [12]. An appropriate antibiotic should be used prophylactically when needed. Choice of antibiotic depends on the type of surgery, area of surgery and etiological agents. Antibiotics should be used precisely according to patient wound types and patient physical conditions. Consistent with the national clinical guideline, Prophylactic antibiotics are highly recommended for transurethral resection of the prostate, Caesarean section, Appendicectomy, Colorectal surgical procedure, and Arthroplasty surgery which is the main causes of morbidity and mortality among patients undergone surgical procedure. Moreover, increases the medical institution costs and duration of hospital stay [13].

Study criteria

A) **Inclusion criteria:**

1. Patient undergone surgery.
2. Patient of age above 18 years.
3. Patient who are willing to participate in the study.

B) **Exclusion criteria:**

1. Surgery where there is no need for prophylactic antibiotics.
2. The post-operative follow up was missed.
3. Pregnant and nursing mother.
4. Psychiatric patient.

Material and Method

A descriptive, prospective and hospital-based study was conducted in Jayanagar General Hospital, Bangalore in department of general surgery over a period of 6 months, after obtaining the clearance and approval from the Institutional Ethics Committee.

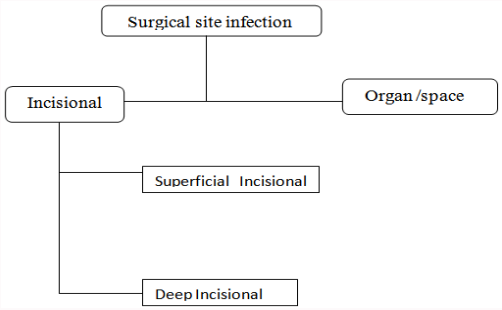

Figure 2: Classification of SSI [9,10].

Table 2: Patient demographics.

Patient Characteristics	No. of Patients	Percentage
Gender distribution		
Male	88	48.89%
Female	92	51.11%
Age distribution		
0-20	22	12.22%
21-30	35	19.44%
31-40	52	28.89%
41-50	59	32.78%
51-60	6	3.33%
Education distribution		
Primary	29	16.11%
Secondary	25	13.88%
PUC	20	11.11%
No formal education	101	56.12%
Occupation		
Agriculturist	28	15.55%
Self employed	67	37.22%
In service	23	12.78%
House wife	41	22.77%
None	21	11.66%

Statistical analysis

Descriptive statistics is done by measuring different proportions. Statistical measurement was done in SPSS trial version 24.0. Graphical representation was done in using Microsoft Excel.

Results

Patient demographics

A total of 180 patients were enrolled in the study, which satisfies inclusion and exclusion criteria. 88 (48.89%) were males and 92 (51.11%) were females. majority of patient were found under the age group of 41 to 50 years 59 (32.78%) followed by 52 (28.89%) patients under 31 to 40 years; 35 (19.44%) patient under 21 to 30 years, 22 (12.22%) patients under 0 to 20 (18 to 20) years, 6 (3.33%) patient age under 51 to 60 years and patient over 60 years, 6 (3.33%). Among them 56% of patient having no formal education, 16.11% have primary education followed by 13.88% secondary, 11.11% PUC education and 2.77 having degrees and 56.12% patient enroll any of occupation was 88.34% (Table 2).

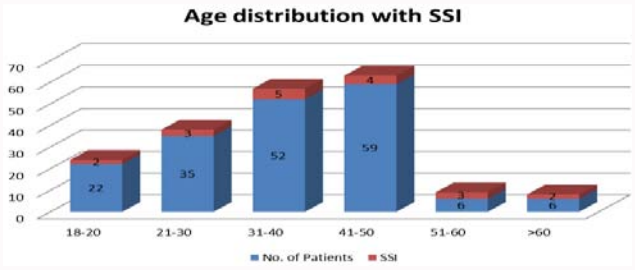

Figure 3: Age distribution and SSI.

Table 3: Presence of risk factor associated with infection.

S.N	Risk factors	No of patient	Percentage	No of SSI	Percentage
1	Anemia	26	14.44%	4	2.22%
2	Blood loss	5	2.77%	-	-
3	DM	6	3.33%	3	1.66%
4	DM+HTN	5	2.77%	2	1.11%
5	HTN	4	2.22%	2	1.11%
6	**Infection**	**3**	**1.66%**	**2**	**1.11%**
7	Obesity	6	3.33%	-	-
8	Smoking	38	21.11%	2	1.11%
9	None	87	48.33%	4	2.22%
Total		180	100%	19	10.50%

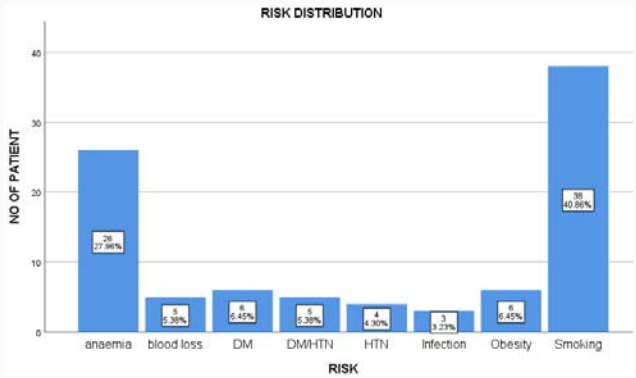

Figure 4: Risk distribution.

Age distribution and SSI

Increasing age increases the incidence of surgical site infections. Out of these, age (51 to 60) is 3 out of 6 is 50%, >60 age is 2 out of 6 is 33.33% and age (41 to 50) is 8% followed by 4 out of 59 patient, 5 out of 52 patient, 2 out of 22, 3 out of 35 (Figure 3).

Presence of risk factor associated with infection

Among 180 patients in this study, 93 patient (51.66%) is having previous risk factor, Among them 40.86% were smokers, 27.96% are anemic, followed by patient associated with DM, DM/HTN, obesity, blood loss and other infection. Coexisting infected patient is 2 among 3 which are 66.67% (Table 3, Figure 4).

Duration of operation to discharge depending upon present of SSI

Shown in Table 4 (Figure 5).

The length of hospital stay after surgery had increased more than 3 times for the patient with SSI than patient who did not have SSI. It imposes increased cost burden to the patient.

Table 4: Duration of operation to discharge depending upon present of SSI.

	No of Hospital Stay		
	Average	Minimum	Maximum
Patient having SSI	11.85	9	18
Patient not having SSI	4.45	4	8

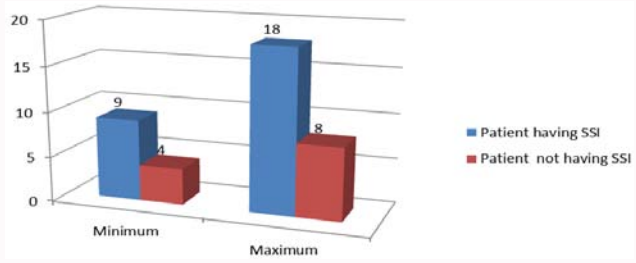

Figure 5: Patient with SSI than patient who did not have SSI.

Table 5: Incidence of SSI and Gender.

S.N	Gender	Total no of patient	SSI	Percentage
1	Male	88	10	5.55%
2	Female	92	9	5.00%
	Total	180	19	10.55%

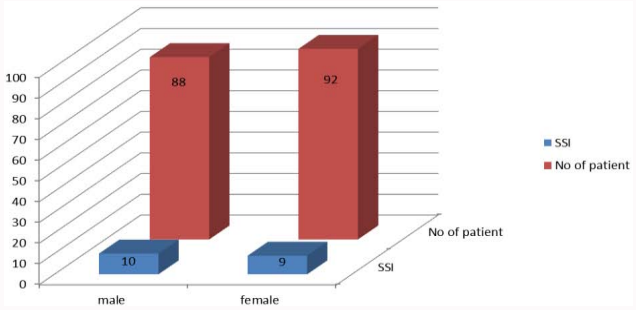

Figure 6: Incidence of SSI and Gender.

Incidence of SSI and gender

Among 180 patients enrolled in the study, out of 88 male patient 10 developed infections, i.e. 5.55% of total patient. Whereas among 92 female patient 9 developed infection, i.e. 5% of total patient enrolled in the study. This suggested that both sex have equal chances of developing infection (Table 5, Figure 6).

Distribution of bacteria associated with infection

Out of 19 patient with SSI patient undergone for culture tests. Ten patient (52.63%) infected patient have *staphylococcus* infection, 3 (15.79%) are having *pseudomonous aerogenosa* followed by 2 (10.53%) with *E. coli*, 2 (10.53%) *enterococcus*, 2 (10.53%) *klebsiella pneumonia*. From culture and the incidence of isolated organisms after SSI in different populations. *Staphylococcus* was more in female rather than male and the *pseudomonous*, *E. coli*, *klebsiella*, *enterococcus* is having similar incidences in male and female. Those pathogens showed differences for sensitive *Staphylococcus aureus* and *Pseudomonas aeruginosa*, which were more frequent in women than male (Table 6).

Wound classification

102 (56.67%) were having clean-contaminated wound, 56 (31.11%) were having clean wound followed by 20 (11.11%) were

Table 6: Distribution of bacteria associated with infection.

Gender	Population	SSI Rate	Isolated Organism	No of Organism
Male	88	10	*Staphylococcus aureus*	3
			E. coli	1
			Pseudomonas aeruginosa	2
			Klebsiella	1
			Enterococcus	1
Female	92	9	*Staphylococcus aureus*	7
			E. coli	1
			Pseudomonas aeruginosa	1
			Klebsiella	1
			Enterococcus	1
TOTAL	**180**	**19**		**19**

Table 7: Wound classification.

S.N	Wound	No of surgery	Percentage
1	Clean	56	31.11%
2	Clean-contaminated	102	56.67%
3	Contaminated	20	11.11%
4	Dirty	2	1.11%
Total		180	100%

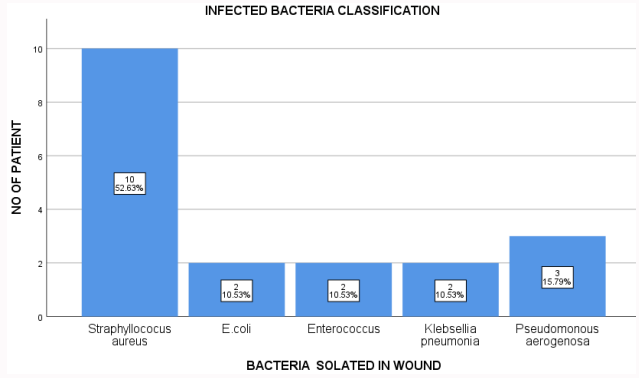

Figure 7: Infected bacterial classification.

having contaminated and 1.11% having dirty wound (Table 7, Figure 7).

Surgery Performed

Shown in Table 8.

Discussion

A hospital based, prospective study was carried out for a period of six months. A total of 180 patients from the general Surgery department of general hospital (only in-patients) who satisfied the study criteria and consented to participate were included. Jayanagar General Hospital is 300 bedded governmental hospitals with advanced practices of ICU, NICU, dialysis etc. Among all cases 88 (48.89%) were male patient and 92 (51.11%) were female patient. The finding is similar to the case carried out by Corinn Langelotz et al. reported no gender-specific differences were found in general surgery. Isolated pathogens showed differences for sensitive *Staphylococcus aureus* and *Pseudomonas aeruginosa*, which were more frequent in women than male [1].

Table 8: Surgery Performed.

Timing of pre-operative administration of antibiotic			
Timing of administration	No of surgery/percentage	SSI	Percentage
Before 1 hours	89 (49.44%)	12	13.48%
Before 1.5 hours	45 (25%)	3	6.66%
Before 2 hours	33 (18.33%)	2	6.06%
>2.5 hours	13 (7.22%)	2	15.38%
No of antibiotics used and associated with SSI			
No of antibiotics used	No of patients	SSI	Percentage
Single antibiotics	37	6	16.66%
Double antibiotics	120	10	8.33%
three antibiotics and more	23	3	13.04%
No of hospital stay			
0-4	59		32.77%
5-8	94		52.22%
9-12	22		12.22%
13-16	4		2.22%
>16	1		0.56%

The age-wise distribution of patient, In our study we found that majority of patients belong to the age group of 41 to 50 years, 31 to 40 years, and 21 to 30 years (32.78%, 29.89%, 19.44%) respectively. Showing that adult patient is more chances for surgical problems like appendicitis, hernia, hydrocele, fissure in and rather than old one. Similar study was conducted by Gandage et al. showing similar distribution of patient undergoes the surgery [2].

High incidence of SSI is associated with DM, DM/HTN, infection are 2.22%, 1.11%, 1.11% of total population. Moderate incidence associated with smoking and anemia whereas less associated with obesity similar study conducted by Gandage et al. shows patient with associated infection, DM, DM/HTN are highly associated with SSI [2]. The incidence of SSI with or without infection shows that patient having 66.01% more chances of having SSI rather than patient not having associated infection. Study conducted by Zeenet Aktar et al. shows that patient with infection is 69.22% more associated with co-existing infection [4]. Shows the hospital stay of patient who developed infection or not developed infection. Tamer Sayed et al. conduct study on antimicrobial study on SSI results shows that the length of hospital stay after surgery had increased incidence more than 3 times for the patient with SSI than patient without SSI. In our study shows that mean day of stay from operation to discharge is 11.85 days (with SSI), 4.45 (Without SSI). Hospital stay ranges in (9 to 18 days in patient develop SSI), (4 to 8 days in patient without develop SSI) shows the incidence of SSI over gender distribution of patient. Almost male and female have similar incidence of developing SSIs, out of 88 male patient 10 person develop, out of 92 patient 9 person develop infection that is 5.55% for male and 5% for female respectively. Corinn Langelotz et al. reported No gender-specific differences were found in general surgery [1]. Shows 5 types of microorganism identified in the culture test. *Staphylococcus aureus* was the most common organism identified in 10 (52.63%) patients followed by *Pseudomonas Species* (15.79%), *Klebsiella* (10.53%), *Enterococcus* (10.53%) and *E. Coli* (10.53%). Sheikh Mohamood et al. shows the similar result in their study where *staphylococcus* is the major organisms develop SSI. According to ASHP guidelines for antimicrobial prophylaxis in clean surgery only no or one dose

antibiotics is enough, while clean contaminated and other require two or more antibiotics to prevent infection [7]. Shows the incidence of SSI in population age distribution showed that, incidence of getting infection is more in age above 40 years. Our study showed that patient with >40 years chances of infection after surgery is increased, age (51 to 60) is 3 out of 6 is 50%, >60 age is 2 out of 6 is 33.33% and age (41 to 50) is 8%. Tamer Saied et al., explain the study resulted that patient with higher age is more likely to chances of SSI. SSI increases the length of hospital stay and increases the cost of the therapy in our study patient without infection spent shorter time compare with patient develop SSI. Our study shows 89.52% patient stay in hospital for less than 8 days does not develop infection where those develop infection stays >9 days. 52.22% stays hospital for 5 to 8 days, 32.77% stay <4 days, 12.22% stays for 9 to 12 days and remaining for >12 days. This study helps to find the correlation between plasma drug concentrations and the infection. David C Classen et al. [14] where the relation between the timing of antibiotic prophylaxis in clinical practice and the occurrence of surgical wound infection has been well studied. They found that use of antibiotics with in the 2 h period before incision associated with lowest rate of wound infection and those receive surgery more than 2 h before have more likely to have chances for infection [9]. In our study 49.44% patient received antibiotics before 1 h of incision, 25% patient received before 1.5 h, and 18% patient received before 2 h and 7.22% of patient receive after 2 h. Among our results about 92.78% patient received antibiotics before 2 h. This is rational use of antibiotics pattern and 7.22% received after 2 h.

Conclusion

Hospitalized patient are highly prone to get an infection. Most common is surgical site infection which leads to the prolonged hospital stay, increase cost of therapy, cause morbidity, disability; increase the cost of healthcare and even mortality. Regardless of numerous research and great practice in surgery operating room, use of prophylactic antibiotics, infection still remains the second one most common adverse event happening in hospitalized affected person and a primary source of mortality and morbidity following surgical procedures. The study revealed that most of the antibiotics prescribed are 3rd generation cephalosporin, cefotaxime, ceftriaxone and amikacin is the most common antibiotics used in hospital. The study has indicated that some prophylactic antibiotics practices are inappropriate. Two or three antibiotics combination received by patient who is not recommended by any guidelines prolonged use of post-surgery prophylaxis is not recommended. This increases the cost of therapy. Patient with diabetes, old age and associated infection is the most common cause developed infection.

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