



SAINT PAUL HOSPITAL MILLENIUM MEDICAL COLLEGE

**TITLE: INCIDENCE AND RISK FACTORS OF SURGICAL SITE
INFECTION AFTER CESAREAN SECTION AT THREE
TEACHING HOSPITALS IN ADDIS ABABA, ETHIOPIA**

BY: DR. LIDYA CHANYALEW (MD, YEAR IV RESIDENT, OBGYN)

ADVISOR – DR. BETHEL DEREJE (MD, OBGYN, ONCOLOGIST)

**A RESEARCH SUBMITTED TO SAINT PAUL’S HOSPITAL MILLENNIUM
MEDICAL COLLEGE, DEPARTMENT OF OBSTETRICS AND
GYNECOLOGY AS PARTIAL FULFILLMENT FOR SPECIALTY
CERTIFICATE IN OBSTETRICS AND GYNECOLOGY**

JULY, 2019

ADDIS ABABA, ETHIOPIA

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ACKNOWLEDGEMENT

I would like to thank the College for allowing me to do this research and the staff at each hospital working in the labor wards and post-natal clinics, for their support during data collection. The Nurses, Interns, General Practitioners and Residents at the post-natal clinics were very helpful and were continuously checking with me throughout the data collection and my greatest thanks goes out to them. Dr. Bethel Dereje, my advisor and mentor, thank you for being by my side through the development of the proposal and the final paper and your constant advice and support.

ACCRONYMS AND ABBREVIATIONS

CD-Cesarean Delivery

SSI-Surgical site infection

SSSI-Superficial Surgical site infection

CDC- Centers for Disease Control and Prevention

WHO- World Health Organization

HAI-Hospital acquired infection

LMICD- low and middle-income countries

HIV-Human immunodeficiency virus

CI-confidence interval

P-prevalence

OR-Odds Ratio

COR-Crude Odds Ration

AOR-Adjusted Odds Ratio

SD-Standard Deviation

A.A.-Addis Abeba

AAU-Addis Abeba University

SPHMMC-St. Paul Millenium Medical College

RDDH-Ras Desta Damtew Hospital

Y12HMC-Yekatit 12 Hospital Medical College

OBGYN-Obstetrics and Gynecology

SVD-Spontaneous vertex delivery

ABSTRACT

Background

Surgical site infection (SSI) following cesarean delivery is a major cause of morbidity and mortality, increasing both the duration of patient hospitalization and hospital costs. Nearly 18.5 million CD are performed in the world each year. Today, in Ethiopia the CD rate is at 2%; and on the contrary one of every three deliveries at SPHMMC is by CD. SSI should be suspected within 30 days of a surgical procedure. The global estimate of surgical site infections (SSI) are from 0.5–15%.

Objectives

To determine the incidence and risk factors of surgical site infections after CD in 3 teaching hospitals in A.A. from January 1, 2019 to March 2, 2019.

Methods

Hospital based cross-sectional study was employed using patient interview in three teaching hospitals in Addis Abeba, Ethiopia, from January 1, 2019 to March 2, 2019. The Centers for Disease Control and Prevention (CDC) state that SSI should be suspected within 30 days of a surgical procedure if at least one of the following symptoms is present: localized swelling, with or without purulent discharge from the wound, pain or tenderness, redness, malodor or fever. And this was used to define cases.

Results

Amongst the 459 mothers who underwent CDs, 68 (14.8%) developed SSI, of which 59 (86.6%) were superficial SSI and 8 (11.7%) were deep SSI and 1 (1.7%) developed organ space SSI. Mothers who were uneducated were 1.21 times more likely to have SSI (AOR=1.55, 95% CI 1.15, 2.095). Having one or more comorbidities was 2.62 times more likely to develop SSI (AOR=2.51 95% CI 1.63, 3.89). ROM>12 hours was associated with 14.22 times risk of developing SSI than those who had intact membranes (AOR=28.00 95% CI 10.08, 77.78). Prematurity was also associated with the risk of developing SSI by 1.33 times (AOR=1.30, 95% CI 1.05, 1.62). Having >5 vaginal exams has 2.89 times more risk to develop SSI (AOR=1.00 95% CI 0.35, 2.86). Mothers who had longitudinal abdominal incision had a 3.13 odds of developing SSI (AOR=3.19 95% CI 1.19, 8.58).

Conclusion

The results obtained in this study show a significant number of SSI which is higher than other studies done in the country. Independent risk factors that are identified are prolonged ROM, repeated vaginal exam, comorbidities, fetal prematurity and type of abdominal incision.

INTRODUCTION

Background

Motherhood is a life-changing event. Successful physiological, as well as psychological, adjustment will be compromised when the arrival of the baby is coupled with recovery from major abdominal surgery and coping with the pain and discomfort of an abdominal wound.

Caesarean Delivery (CD) is a surgical procedure where a baby is delivered by cutting through the front wall of the abdomen to open the uterus [1]. Cesarean Delivery is one of the most commonly performed surgical procedures in OBGYN. Surgical site infection (SSI) after a cesarean section increases maternal morbidity and prolongs hospital stay and medical costs [2].

An estimated 18.5 million CD are performed worldwide each year [3]. Today, in Ethiopia CD rate is about 2% [4]; and one of every three deliveries is by CD in this hospital. Although this procedure has become routine, it is not benign. Cesarean section brings an increased risk of maternal morbidity and mortality when compared to vaginal deliveries [5].

The Centers for Disease Control and Prevention (CDC) state that SSI should be suspected within 30 days of a surgical procedure if at least one of the following symptoms is present: localized swelling, with or without purulent discharge from the wound, pain or tenderness, redness, malodor or fever.

Surgical site infection (SSI) following cesarean delivery is a major cause of morbidity and mortality, increasing both the duration of patient hospitalization and hospital costs [2, 6-8]. The global estimates of surgical site infections (SSI) are from 0.5–15% [9]. Maternal infectious morbidity has been shown to be eight-fold higher after cesarean delivery than after vaginal delivery. The SSI after caesarean section causes physical, psychological and economic burden to woman, her family and to the community [2]. Post CD wound infection can seriously affect a woman's quality of life at a critical time when she is recovering from an operation and has a new born baby to look after. In high income countries, approximately 2% of surgeries are affected by SSIs [10, 11]. World Health Organization (WHO) shows that SSIs are most frequently reported type of HAI in low and middle-income countries (LMICD) with a pooled incidence of 11.8 episodes of SSI per 100 surgical procedures [10].

World Bank classifies countries into four income groups: Low-income is <1005 GNI/capita, Lower-middle income is 1006-3955 GNI/capita, Upper-middle income is 3956-12,235 GNI/capita and High-income is >12,235 GNI/capita (current USD) [12].

Among the risk factors described for SSI are prolonged labor, premature rupture of membranes, excess vaginal manipulation, manual extraction of the placenta, and premature birth. [13-16] Comorbidities such as HIV, severe anemia and gestational diabetes are also associated with higher rates of puerperal infection, particularly surgical wound infection. [17, 18] As we live in the Sub-Saharan region,

where women have labored home for long hours before they arrive to a health care facility where the patient load is high, the risk factors to develop SSIs might be higher and the incidence is worth looking at. Many studies have proved that antimicrobial prophylaxis is effective in reducing the incidence of postoperative wound infections as it reduces the risk of resident bacteria overcoming the immune system in the immediate postoperative period. [19-21]

As infection continues to be a common postoperative complication in both the developed and developing world, there is a need to implement SSI surveillance during and after surgeries so as to obtain a standardized incidence. [22] And so as to help increase the awareness among the health care professionals for the prevention of this problem in the hospital the knowledge of incidence and associated risk factors of SSI after CD is necessary. LMIC are resource limited and may only have rudimentary data collection systems and having systems in place may help to ensure quality of care ahead of time. And this can be started by knowing the incidence of this problem which will be a ground for further studies and also for quality improvement. The aim of this study was to estimate the occurrence of and also the factors associated with a 30-day postoperative SSI after Cesarean Delivery.

Statement of the problem

Cesarean section brings an increased risk of maternal morbidity and mortality when compared to vaginal deliveries [5].

Surgical site infection (SSI) following cesarean delivery is a major cause of morbidity and mortality, increasing both the duration of patient hospitalization and hospital costs [2, 6-8]. The global estimates of surgical site infections (SSI) are from 0.5–15% [9]. Maternal infectious morbidity has been shown to be higher after cesarean delivery than after vaginal delivery. Post CD wound infection can seriously affect a woman's quality of life at a critical time when she is recovering from an operation and has a new born baby to look after. SSIs are most frequently reported type of HAI in low and middle-income countries (LMICD) with a pooled incidence of 11.8 episodes of SSI per 100 surgical procedures [10].

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Significance of the study

Researches done so far regarding wound infection after cesarean section are in other capitals of the country like Hawassa. As we live in a sub-saharan country where women have labored for long hours at home or in a health center, infection risks are undeniable. And wound infections are commoner than known or assumed.

This study will provide as a basis for further researches and also will give a brief idea of the risk factors involved with wound infection after cesarean section.

The knowledge of incidence and associated risk factors of SSI after CD will help to increase the awareness among the health care professionals for the prevention of this problem in the hospital. And this can be started by knowing the incidence of this problem which will be a ground for further studies and also for quality improvement.

OBJECTIVES

General Objective

- To determine the incidence and risk factors of surgical site infections at 3 teaching hospitals in Addis Abeba, from January 1, 2019 to March 2, 2019.

Specific Objectives

- To determine the incidence of SSI at 3 teaching hospitals in Addis Abeba, from January 1, 2019 to March 2, 2019.
- To determine the factors of SSI at 3 teaching hospitals in Addis Abeba, from January 1, 2019 to March 2, 2019.
- To describe the associations between labor characteristics and SSI at 3 teaching hospitals in Addis Abeba, from January 1, 2019 to March 2, 2019.
- To evaluate the correlation of level of resident operating and SSI at 3 teaching hospitals in Addis Abeba, from January 1, 2019 to March 2, 2019.
- To describe the socio-demographic characteristics of patients with SSI at 3 teaching hospitals in Addis Abeba, from January 1, 2019 to March 2, 2019.

METHODS

Study setting

The study was conducted at three teaching hospitals in Addis Abeba, which are staffed by SPHMMC's OBGYN residents: SPHMMC, RDDH, Y12HMC. SPHMMC and RDDH are located to the west of the center of A.A. on the road to Ambo and Y12HMC is located at 6 kilo (Yesematat Metasebiya) square in front of AAU.

SPHMMC has the largest catchment area from the 3 hospitals with the largest number of deliveries and CD rate. These 3 hospitals have a minimum of 4 OBGYN consultants and residents from each year and interns with midwives and nurses.

SPHMMC has a total of 800 deliveries per month in average, of which approximately 35% of them deliver with CD. Y12HMC has the second largest deliveries from the three hospitals at approximately 400 per month with 30% CD rate. RDDH recently started MCH services and has around 200 deliveries per month with 30% CD rate.

These three hospitals are chosen because of their location and also uniformity of the staff, despite the fact that patient profile may be different, as majority of the patients coming to either RDDH or Y12HMC are from Addis Abeba while only nearly half of patients coming to SPHMMC are from Addis Abeba.

Study Design

Hospital based cross-sectional study design was employed using patient interview and chart review.

Study population

The source population was all women who came to deliver at these 3 hospitals until the sample size was attained during the study period.

Inclusion and Exclusion criteria

Inclusion Criteria

- All women who delivered with cesarean section at the three teaching hospitals until sample size was attained during the study period who gave consent.

Exclusion Criteria

- Women who developed SSI after 30 days.
- Women who underwent re-laparotomy for reasons other than SSI.
- Maternal death from reasons other than SSI.

Sample size

Sample size was determined using a single population proportion formula by taking $p=0.11$ from a study done in Hawassa University Teaching Hospital, Southern Ethiopia and margin of error (d) 0.03. And the sample size was calculated to be 460.

Sampling procedures

All women who delivered with Cesarean Section were included in this study using convenient sampling. Those who did not fulfill the inclusion criteria were excluded from the study.

Data collection procedures

Data was collected by using a pretested questionnaire from January 1, 2019 to March 2, 2019 from those women who gave consent. All the variables were assessed and the questionnaire was prepared in English. Data collectors were interns or residents posted at labor ward for enrollment of clients and post natal clinics in the respective hospitals. Orientation was given to the data collectors on how to conduct the data collection.

All patients were appointed on the 7th day and 30th day of the operation after their discharge on the 3rd day and information was collected both from charts and clients as well. And women who couldn't come for their appointment were communicated through phone.

Analytical statistics: bivariate logistic regression analysis for each independent variable with $p\text{-value} < 0.1$ was done and variables showing $p\text{-value} < 0.1$ was taken for multivariate logistic regression analysis and then significance was declared for variable having $p\text{-value} < 0.05$.

Data management and analysis

The data was checked for completeness, inconsistencies and missing values and then coded, entered, cleaned and analyzed using SPSS version 20. Descriptive data statistics was made using frequency and percentage. Bivariate and multivariate logistic regression analyses were done to

identify the predictors of SSI. The outputs of the analysis are provided using crude and adjusted OR (COR and AOR).

Ethical consideration

Ethical consideration for patients' consent to participate in the study was strongly regarded after disclosing the research fully. Interns and residents involved in the study were strongly advised to be careful and disclose all information in terms that the patients understand to the fullest extent. Patients were made aware about the research and that the results are not predictable or that it doesn't mean that it predicts if they will develop their chances of developing SSI. For further ethical consideration approval was granted from the Institutional Board Review (IRB) and each hospital department.

RESULTS

Sociodemographic and medical characteristics

There were 72 women who were lost from follow up; of which 17 (23.6%) declined to give consent, 26 (36.1%) were unreachable over the phone and 29 (40.3%) didn't come back for the first visit and their phones were also not available. Of the total CDs during the study period, 46% of the women were having their follow-up through the phone and of which half developed SSI.

Among the 459 CDs done in the respective hospitals, the median age group was from 20-29(Table 1). Regarding parity, 204 (44.4%) were para 1, and 139 (30.3%) were para 2. Antenatal booking was observed for 447 (97.4%) and only 12 (9.6%) were not and from the booked ones 84 (18.3%) had their ANC follow up at SPHMMC, 39 (8.5%) at RDDH, 60 (13.1%) at Y12HMC and 276 (60.1%) at other centers. And of the booked mothers 332 (72.3%) had at least 1-4 visits while 127 (27.7%) had more than 4 visits (Table 2).

Table 1 Socio-demographic distribution of women with and without SSI at 3 teaching hospitals in Addis Abeba, from January 1st to March 2nd, 2019

		SSI		
		Yes (%)	No (%)	Total
Age	<19	3 (4.5)	13 (3.3)	16 (3.4)
	20-29	46 (67.6)	274 (70.1)	320 (69.7)
	30-39	19 (27.9)	103 (26.3)	122 (26.6)
	>40	0 (0)	1 (0.3)	1 (0.3)
Religion	Christian	57 (83.8)	298 (76.2)	355 (77.3)
	Muslim	11 (16.2)	93 (23.8)	104 (22.7)
Marital status	Married	66 (97.1)	379 (96.9)	445 (96.9)
	Single	0 (0)	9 (2.3)	9 (2)
	Widowed	2 (0.9)	0 (0)	2 (0.5)
	Divorced	0 (0)	3 (0.8)	3 (0.6)
	Others	0 (0)	0 (0)	0 (0)
Educational Level	None	8 (11.8)	33 (8.4)	41 (8.9)
	Write & read	7 (10.3)	36 (9.2)	43 (9.3)
	Primary	31 (45.6)	139 (35.5)	170 (37.2)

	Secondary	14 (20.5)	109 (27.9)	123 (26.8)
	College	4 (5.9)	53 (13.6)	57 (12.4)
	Others	4 (5.9)	21 (5.4)	25 (5.4)
Employment Status	Unemploye	44 (64.7)	254 (64.9)	298 (64.9)
	Self employed	9 (13.2)	56 (14.3)	65 (14.2)
	Government	9 (13.2)	40 (10.3)	49 (10.7)
	Private	6(8.9)	39 (10)	45 (9.8)
	Others	0 (0)	2 (0.5)	2 (0.4)
	Total	68 (100)	391 (100)	459 (100)

Table 2: Obstetric Performance of women with and without SSI at 3 teaching hospitals in Addis Abeba, from January 1st to March 2nd, 2019

		SSI		
		Yes (%)	No (%)	Total (%)
ANC	Yes	67 (98.5)	380 (97.2)	447 (97.4)
	No	1 (1.5)	11 (2.8)	12 (2.6)
How Many Times	1-4	42 (61.8)	290 (74.2)	332 (72.3)
	>4	26 (38.2)	101 (25.8)	127 (27.7)
Where	SPHMMC	19 (27.9)	65 (16.6)	84 (18.3)
	RDDH	4 (5.9)	35 (9)	39 (8.5)
	Y12HMC	3 (4.4)	57 (14.6)	60 (13.1)
	Others	42 (61.8)	234 (59.8)	276 (60.1)
Miscarriages	Yes	16 (23.5)	49 (12.5)	65 (14.2)
	No	52 (76.5)	342 (87.5)	394 (85.8)
Parity	1	27 (39.7)	177 (45.3)	204 (44.4)
	2	24 (35.3)	115 (29.4)	139 (30.3)
	3	13 (19.1)	56 (14.3)	69 (15)
	4	3 (4.4)	23 (5.9)	26 (6.1)
	5	0 (0)	13 (3.3)	13 (2.6)
	6	1 (1.5)	4 (1)	5 (1.1)
	7	0 (0)	2 (0.5)	2 (0.3)

	8	0 (0)	1 (0.3)	1 (0.2)
HIV Status	NR	63 (92.6)	368 (94.1)	431 (93.9)
	R	3 (4.4)	7 (1.8)	10 (2.2)
	UK	2 (2.9)	16 (4.1)	18 (3.9)

There were 28 losses to follow up women of which 6 of them declined consent after CD, 11 of them never came back for the 7th day follow up and their phones were also not working, and 11 of them had either wrong number, didn't answer their phone and their phones were out of reach.

Table 3: Surgery Circumstances of women with and without SSI at 3 teaching hospitals in Addis Abeba, from January 1st to March 2nd, 2019

		SSI		
		Yes (%)	No (%)	Total (%)
Hospital	SPHMMC	37 (54.4)	261 (66.8)	298 (64.9)
	RDDH	15 (22.1)	47 (12)	62 (13.5)
	Y12HMC	16 (23.5)	83 (21.2)	99 (21.6)
Order Of CD	1 st	45 (66.2)	342 (87.6)	387 (84.3)
	2 nd	16 (23.5)	45 (11.6)	61 (13.4)
	3 rd	6 (8.8)	3 (0.5)	9 (1.9)
	>4	1 (1.5)	1 (0.3)	2 (0.4)
GA	<34 Weeks	12 (17.6)	31 (7.9)	43 (9.3)
	34-36+6 Weeks	10 (14.7)	47 (12)	57 (12.3)
	37-39+6 Weeks	20 (29.4)	62 (15.9)	82 (17.7)
	40-41+6 Weeks	10 (14.7)	75 (19.2)	85 (18.3)
	>42 Weeks	4 (5.9)	85 (21.7)	89 (19.2)
	Unknown	12 (17.7)	91 (23.3)	107 (23.2)
Hemoglobin	>11	55 (80.9)	388 (99.2)	443 (96.5)
	9-11	12 (17.6)	0 (0)	12 (2.6)
	7-8.9	0 (0)	2 (0.5)	2 (0.4)
	<7	1 (1.5)	1 (0.3)	2 (0.4)

Comorbidities	DM	1 (1.5)	1 (0.3)	2 (0.4)
	HIV	3 (4.5)	7 (1.8)	10 (2.2)
	Anemia	13 (19.1)	3 (0.8)	16 (3.5)
	Others	23 (33.7)	82 (20.9)	105 (22.9)
	None	28 (41.2)	298 (76.2)	326 (71)
In Labor	Yes	51(75)	247 (63.2)	298 (64.9)
	No	17 (25)	144 (36.8)	161 (35.1)
Type Of Surgery	Elective	15 (22.1)	109 (27.9)	124 (27)
	Emergency	53 (77.9)	282 (72.1)	335 (73)
Indication For CD	NRFHR	24 (35.3)	117 (29.9)	141 (30.7)
	Failed Induction	6 (8.8)	25 (6.4)	31 (6.8)
	Meconium	5 (7.4)	16 (4.1)	21 (4.6)
	CPD	3 (4.4)	16 (4.1)	19 (4.1)
	Previous CD	14 (20.6)	33 (8.4)	47 (10.2)
	Malpresentation	5 (7.3)	52 (13.3)	57 (12.4)
	Others	11 (16.2)	132 (33.8)	143 (31.2)
Duration Of Rupture Of Membranes	Intact	15 (22.1)	141 (36.1)	156 (34)
	<12 Hours	20 (29.4)	224 (57.3)	244 (53.2)
	>12 Hours	33 (48.5)	26 (6.6)	59 (12.8)
Number Of Vaginal Exam	None	20 (29.4)	138 (35.3)	158 (34.3)
	1-4	11 (16.2)	117 (29.9)	128 (27.7)
	>5	37 (54.4)	136 (34.8)	173 (38)
Color Of Liquor	Clear	22 (32.3)	93 (23.8)	115 (25)
	G1-G2 MSAF	20 (29.4)	135 (34.4)	155 (33.8)
	G3 MSAF	7 (10.3)	19 (4.9)	26 (5.7)
	Bloody	4 (5.9)	3 (0.8)	7 (1.5)
	Unruptured	15 (22.1)	141 (36.1)	156 (34)
Level Of Resident Operating	1st year	0 (0)	0 (0)	0 (0)
	2nd year	51 (75)	343 (87.7)	394 (85.9)
	3rd year	11 (16.2)	36 (9.2)	47 (10.2)
	4th year	6 (8.8)	12 (3.1)	18 (3.9)
Duration Of Surgery	<30 minutes	9 (13.3)	122 (31.2)	131 (28.6)

	30-60 minutes	56 (82.3)	265 (67.8)	321 (69.9)
	60-90 minutes	3 (4.4)	3 (0.7)	6 (1.3)
	>90 minutes	0 (0)	1 (0.3)	1 (0.2)
Estimated Blood Loss	<500 ml	47 (69.1)	351 (89.7)	398 (86.7)
	500-1000 ml	18 (26.5)	11 (2.8)	29 (6.3)
	1000-1500 ml	3 (4.4)	19 (4.9)	22 (4.8)
	>1500 ml	0 (0)	10 (2.6)	10 (2.2)
Placenta Removal	CCT	63 (92.6)	375 (95.9)	438 (95.4)
	Manual	5 (7.4)	16 (4.1)	21 (4.6)
Type Of Abdominal Incision	Pfannensteil	48 (70.6)	345 (88.2)	393 (85.6)
	Longitudinal	20 (29.4)	46 (11.8)	66 (14.4)
Type Of Skin Closure	Subcuticular	58 (85.3)	373 (95.4)	431 (92.8)
	Interrupted	10 (14.7)	18 (4.6)	28 (7.2)
Timing Of Administration Of Antibiotics	Preoperative	65 (95.6)	382 (97.7)	447 (97.4)
	Intraoperative	3 (4.4)	9 (2.3)	12 (2.6)
	Postoperative	0 (0)	0 (0)	0(0)

Of the total CDs done, 298 (64.9%) were done at SPHMMC, while 62 (13.5%), 99 (21.6%) were done at RDDH and Y12HMC, respectively (Table 4) and of these 124 (27.0%) were elective and 335 (73%) were emergency deliveries. Most of the CDs, 394 (85.8%) were done by 2nd year residents, and 47 (10.2%) were by 3rd year residents and 18 (3.9%) of the CDs were by 4th year residents (Table 3).

Incidence of SSI

Amongst the 459 mothers who underwent CDs, 68 (14.8%) developed SSI, of which 59 (86.6%) were superficial SSI and 8 (11.7%) were deep SSI and 1 (1.7%) developed organ space SSI (Figure 1). From this, 37 (54.4%; 11.1% SSSI, 1.3% Deep SSI and no organ space SSI) were from SPHMMC, 15 (22.1%; 19.4% SSSI, 3.2% Deep SSI and 1.6% organ space SSI) were from RDDH and 16 (23.5%; 14.1% SSSI, 2.0% Deep SSI and no organ space SSI) were from Y12HMC (Figure 3).

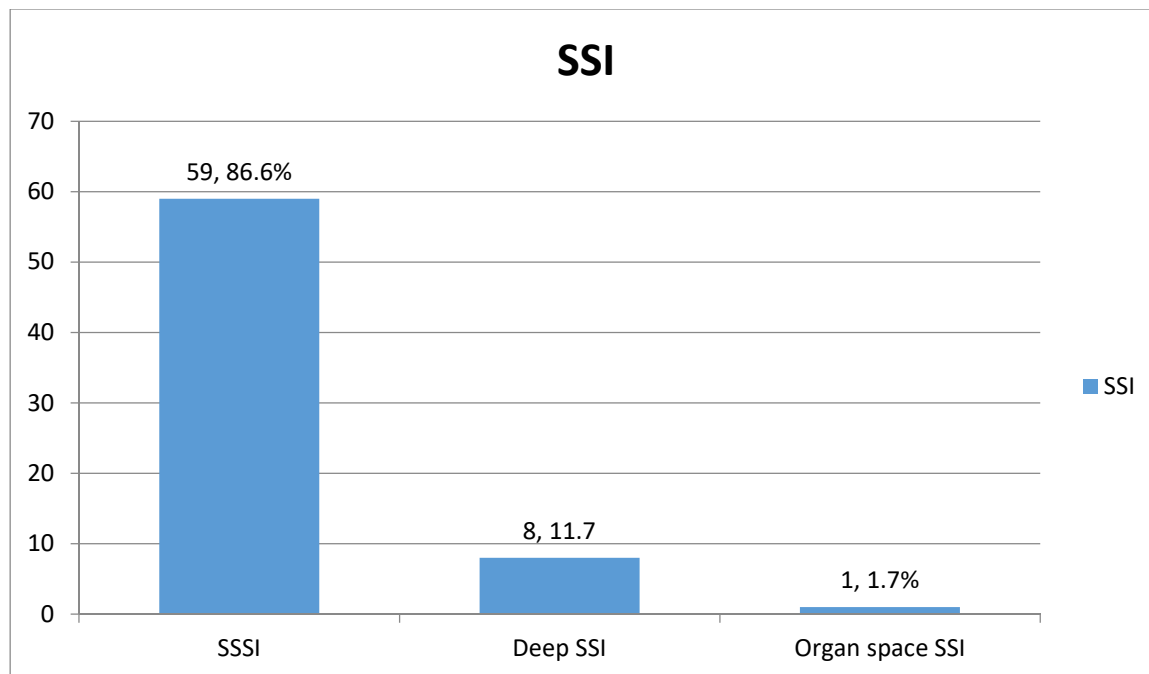


Figure 1: Distribution of SSI at 3 teaching hospitals in Addis Abeba, from January 1st to March 2nd, 2019

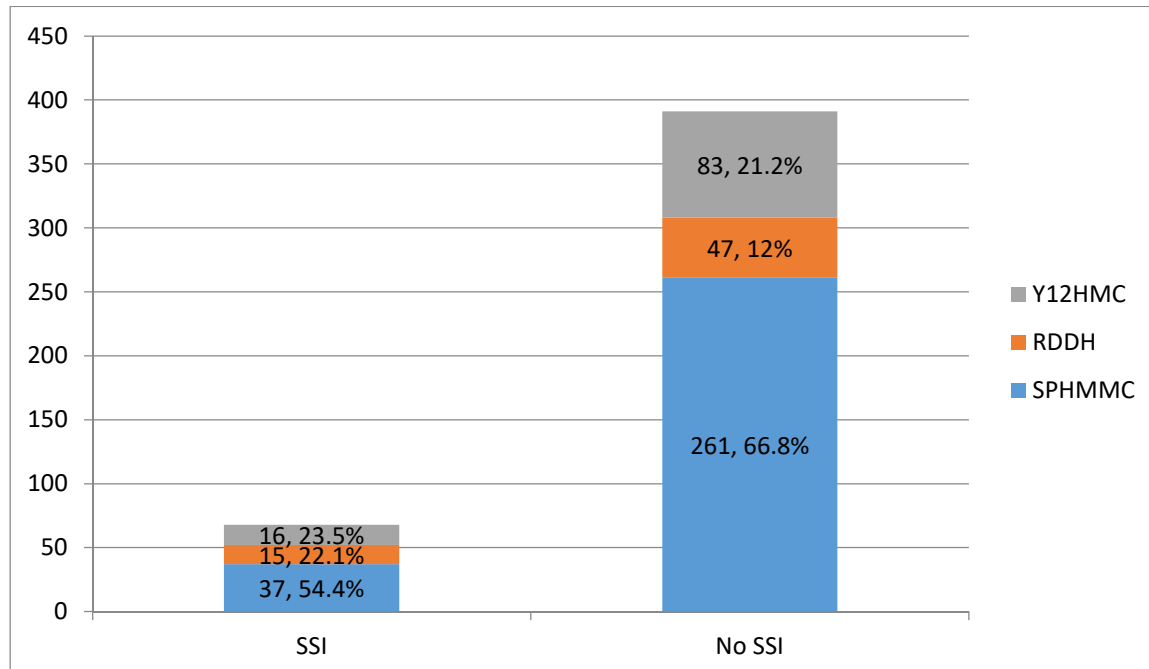


Figure 2: Hospital distribution of SSI at 3 teaching hospitals in Addis Abeba, from January 1st to March 2nd, 2019

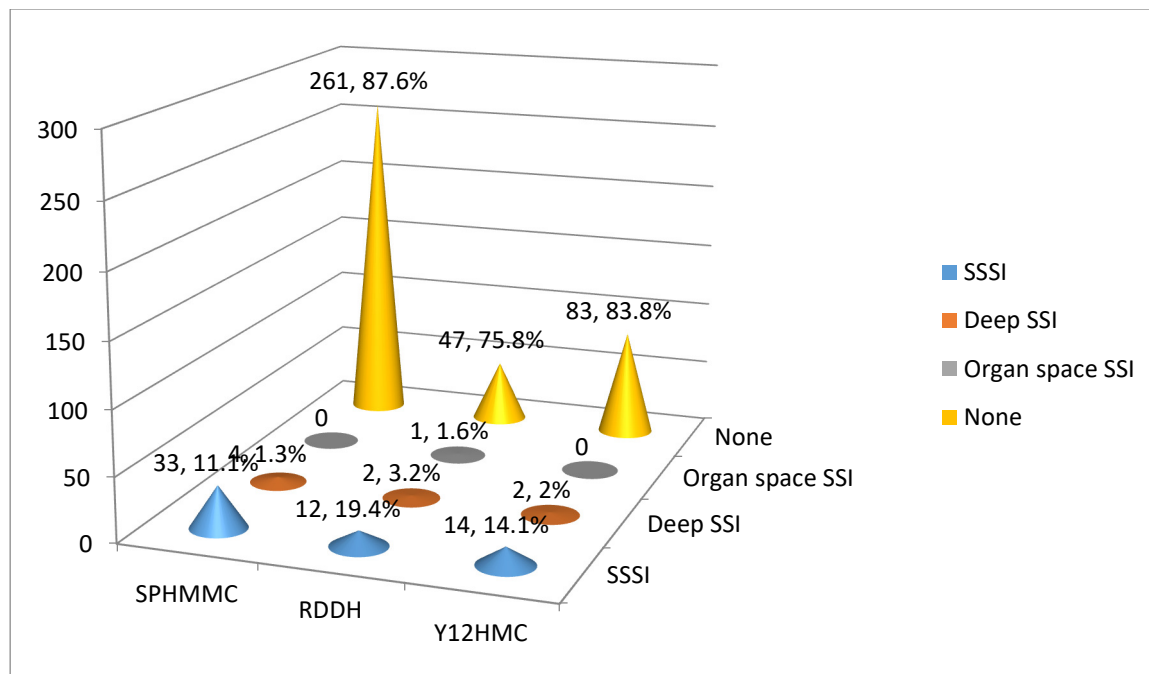


Figure 3: Hospital distribution of category of SSI at 3 teaching hospitals in Addis Abeba, from January 1st to March 2nd, 2019

Factors associated with SSIs after CD

There were 13 variables in binary logistic regression which had a p value of ≤ 0.1 and became candidates for multiple logistic regression; educational level, miscarriage history, ANC visit frequency, comorbidities, GA, presence of labor, indication for C/S, duration of ROM, number of vaginal exam, color of liquor, level of resident operating, type of abdominal incision and type of skin closure.

In multiple logistic regressions, educational level, comorbidities, GA, duration of ROM, number of vaginal exam, and type of abdominal incision were significantly associated with $p \leq 0.05$ (Table 4). Mothers who were uneducated were 1.21 times more likely to have SSI (AOR=1.55, 95% CI 1.15, 2.095). Having one or more type of comorbidities was 2.621 times more likely to develop SSI (AOR=2.51 95% CI 1.63, 3.89). ROM>12 hours was associated with 14.22 times risk of developing SSI than intact membranes (AOR=28.01 95% CI 10.08, 77.78). Prematurity was also associated with the risk of developing SSI by 1.33 times (AOR=1.30, 95% CI 1.05, 1.62). Having >5 vaginal exams has 2.89 times more risk to develop SSI than no vaginal exam (AOR=1.30 95% CI 0.35, 2.86). Mothers who had longitudinal abdominal incision had a 3.13 odds of developing SSI (AOR=3.19 95% CI 1.19, 8.58).

Table 4: Factors associated with SSI at 3 teaching hospitals in Addis Abeba, from January 1st to March 2nd, 2019

	COR	AOR	<i>p</i> -value	95% CI
Educational level	1.21	1.55	0.005	1.15,2.095
Comorbidities	2.621	2.51	0.002	1.63,3.89
ROM>12 hours	14.22	28.01	*	10.08, 77.78
Prematurity	1.33	1.30	0.020	1.05, 1.62
>5 vaginal exam	2.89	1.30	0.038	1.01, 2.86
Longitudinal abdominal incision	3.13	3.19	0.021	1.19, 8.58

**P* <0.005

DISCUSSION

The incidence of surgical site infection following cesarean delivery in this study is 14.8%. This finding is slightly higher than other studies done in Ethiopia. Studies done in Tigray[23] and Hawassa[24], showed 6.8% and 11.0% prevalence, respectively. This might be because of the study design and the setting, considering that both were done at a referral hospital and this study was done at 3 teaching hospitals and follow up, up to 30 days post cesarean delivery was done to track infections.

This study showed that mothers with lower educational background have 1.21 times the odds of developing SSI (AOR=1.55, 95% CI 1.15, 2.095), which is different from other studies. This might be because educated women will have a better understanding of instructions and better access to hygiene products.

In this study mothers with prolonged rupture of membranes had significant odds to develop SSI than controls. Mothers with >12 hours of ROM had 14.22 times more odds to develop SSI than controls (intact membrane) (AOR=28.01 95% CI 10.08, 77.78). Studies done in Nepal[25], Oman[26], Kenya[27], Hawassa[24] and Tigray[23] show similar findings. Prolonged ROM contributes to amniotic fluid colonization from the normal flora of the lower genital tract and lead to surgical wound and peritoneal cavity contamination [28].

The study also showed significant association between comorbidities and SSI development. Specific comorbidities evaluated were DM, HIV and anemia. With comorbidities, the chance of development of SSI is 2.62 fold (AOR=2.52 95% CI 1.63, 3.89). A study done in Brazil showed similar risks in regard to DM and anemia. [29]

Prematurity was slightly associated with odds of developing SSI COR=1.33 (AOR=1.30 95% CI 1.05, 1.620). Similar results have been observed from other studies [2, 6-8]. This might possibly be because premature births usually are associated with other, either fetal or maternal, comorbidities or complications, such as pre-eclampsia or hemorrhage.

Frequent vaginal examination is one of the established risk factors that increase the risk of post-cesarean wound infections. Repeated vaginal examinations can introduce endogenous vaginal flora capable of causing SSI to the upper genital tract [30]. This study's finding is consistent with this background. Women who had 1-4 and >4 vaginal exams had 1.88 and 2.89 times more chance to develop SSI than their controls (no vaginal exams). Study from Hawassa showed similar results with 3 and 9 times respectively and from Tanzania 2.6 times [30].

Another finding in this study was the type of abdominal incision as a risk for SSI. Mothers with longitudinal subumbilical abdominal incision had 3.13 times more chance to have SSI (AOR=3.19 95% CI 1.19, 8.58). Study from Tigray [23] had similar results having 5.7 times risk than their controls. This may be because indications that will require longitudinal subumbilical midline incision are chorioamnionitis,

obstructed labor or urgent CDs or previous incision. And 3 of the above are usually rather hasty and contaminated surgeries putting the patient at risk from the outset [23].

Prolonged duration of surgery, obesity, younger maternal age, and type of skin closure, which were found to be associated with the development of SSI, were not findings in this study.

CONCLUSION

The results obtained in this study show a significant number of SSI (14.8%) which is higher than other studies done in the country. Independent risk factors which were identified are educational level, prolonged ROM, repeated vaginal exam, comorbidities, fetal prematurity and type of abdominal incision. Therefore, to decrease SSI, the department of OBGYN has to establish a system to decrease the incidence and to recognize and act early, such as, patients with prolonged ROM can have a shorter time to delivery and vaginal exam can be few in as much of the patients as possible, comorbidities can be identified and controlled before surgery if possible. In addition, sterile environment and aseptic surgeries, use of WHO surgical safety checklist would appear to be very important intervention to reduce SSI.

LIMITATION OF THE STUDY

The follow up of nearly half (46%) of the patients was through phone, as these patients were either from towns around Addis or had some other personal reasons not to come for the 30th day follow up appointment. And this may have biased the results, because information was gathered only from the patients' words in regards to whether she has signs of infection or not.

As these hospitals are referral hospitals, data reliability regarding the duration of rupture of membranes and more specifically number of vaginal exams might be poor because these were taken mainly from charts or patients' words, again affecting the results.

This study also failed to relate some important factors, such as indication for CD, mainly because; there were so many indications for CD and it was difficult to categorize them systematically. So, instead the most common indications were evaluated separately and the rest were crushed together as "others"

This study was also not powered enough with sample size and time to determine the risk factors as well as it should.

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ANNEXES

Consent

Greetings. My Name is_____. I am working as a postnatal care provider in this hospital. This questionnaire is prepared to assess the incidence of wound infection after cesarean section. Thank you for agreeing to talk with me today.

As part of the research, we are interviewing clients about their obstetrical performance and about what happened during this delivery. The information you share with us will be helpful.

Confidentiality and consent: “I’m going to ask you some personal questions related to your obstetric and gynecologic performances. There is not necessarily any right or wrong answer. I would like to ask you to share your views as freely and completely as possible. We will protect the confidentiality of your responses to the best of our ability. Your name will not be written on this form and will never be used in connection with any of the information you tell me.

Do you agree? YES/NO

Questionnaire

Date

Patient initials

Mobile number

Card no

Research assistant

Socio-Demographic information

1. Age
 - a. 19 and younger
 - b. 20-29
 - c. 30-39
 - d. 40 and older
2. Religion
 - a. Christian
 - b. Muslim
3. Marital status
 - a. Married
 - b. Single
 - c. Widowed
 - d. Divorced
 - e. Others
4. Education level
 - a. None
 - b. Write and read
 - c. Primary
 - d. Secondary
 - e. College
 - f. Others
5. Employment status

- a. Unemployed
- b. Self employed
- c. Government
- d. Private
- e. Others

Obstetric history

- 1. Parity
- 2. Have you had any miscarriages?
 - a. Yes
 - b. No
- 3. GA
 - a. <34 weeks
 - b. 34-36⁺⁶ weeks
 - c. 37-39⁺⁶ weeks
 - d. 40-41⁺⁶ weeks
 - e. >42 weeks
 - f. Unknown

ANC

- 1. Attended ANC
 - a. Yes
 - b. No
- 2. If yes, how many times?
 - a. 1-4
 - b. >4
- 3. If yes, where?
 - a. SPHMMC
 - b. RDDH
 - c. Y12HMC
 - d. Other
- 4. Latest Hgb level

- a. >11 gm/dl
 - b. 9-11 gm/dl
 - c. 7-9 gm/dl
 - d. <7 gm/dl
- 5. HIV status
 - a. Reactive
 - b. Non-Reactive
 - c. Unknown
- 6. Comorbidities
 - a. DM
 - b. PE
 - c. Anemia
 - d. Others
 - e. None
- 7. Order of C/S
 - a. 1st
 - b. 2nd
 - c. 3rd
 - d. 4 and above

Labor History

- 1. Was the patient in labor?
 - a. Yes
 - b. No
- 2. If in labor, duration of rupture of membranes
 - a. Intact membranes
 - b. <12 hours
 - c. >12 hours
- 3. If in labor, number of vaginal examinations before delivery
 - a. None
 - b. 1-4

- c. >4
- 4. Color of liquor, if membrane ruptured
 - a. Clear
 - b. Grade I- Grade II MSAF
 - c. G-III MSAF
 - d. Bloody
 - e. Intact
- 5. Indication for C/S
 - a. NRFHRP
 - b. Failed induction
 - c. Meconium
 - d. CPD
 - e. Previous scar
 - f. Malpresentation
 - g. Others

Operation details

- 1. Hospital
 - a. SPHMMC
 - b. RDDH
 - c. Y12HMC
 - d. Other
- 2. Type of surgery
 - a. Elective
 - b. Emergency
- 3. Level of residency of operator
 - a. Year II
 - b. Year III
 - c. Year IV
- 4. Type of abdominal incision
 - a. Pfannenstiel
 - b. Longitudinal

5. Duration of surgery
 - a. <30 minutes
 - b. 30-60 minutes
 - c. 60-90 minutes
 - d. >90 minutes
6. Estimated blood loss
 - a. <500 ml
 - b. 500-1000 ml
 - c. 1000-1500 ml
 - d. >1500 ml
7. Timing of administration of antibiotics
 - a. Preoperative
 - b. Intraoperative
 - c. Postoperative
8. Placenta Removal
 - a. CCT
 - b. Manual removal of placenta
9. Type of skin closure
 - a. Subcuticular
 - b. Interrupted
10. Hospital stay
 - a. <1 week
 - b. 1-4 weeks
 - c. >4 weeks

Assessment of infection

Infection indicator

1. At 3 days
2. At 7 days
3. At 30 days

- a. Fever (temperature $>38^{\circ}\text{C}$ beyond the first 24 hours recorded on 2 occasions at least 4 hours apart)
 - b. Purulent discharge from the skin
 - c. Redness, localized tenderness or swelling
 - d. Incision deliberately opened by surgeon
 - e. Incision spontaneously dehisces
 - f. Abscess (purulent discharge in the setting of induration at the incisional site)
4. Category of SSI
- a. Superficial incisional surgical site infection
 - b. Deep incisional surgical site infection
 - c. Organ space surgical site infection