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REVIEW

Burden of surgical site infection following cesarean section in sub-Saharan Africa: a narrative review

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Angie Sway[1]
Peter Nthumba[2]
Joseph Solomkin[3]
Giorgio Tarchini[4]
Ronald Gibbs[5]
Yanhan Ren[6]
Anthony Wanyoro[7]

[1]Medical Writing, World Surgical Infection Society, Cincinnati, OH, USA; [2]Plastic, Reconstructive and Hand Surgery, AIC Kijabe Hospital, Kijabe, Kenya; [3]Department of Surgery, University of Cincinnati College of Medicine, Cincinnati, OH, USA; [4]Department of Infectious Disease, Cleveland Clinic Florida, Weston, FL, USA; [5]Department of Obstetrics and Gynecology, University of Colorado Hospital, Denver, CO, USA; [6]Research and Implementation, World Surgical Infection Society, Cincinnati, OH, USA; [7]Department of Obstetrics and Gynecology, School of Medicine, Kenyatta University, Nairobi, Kenya

Abstract: Cesarean section (CS) is the most common operative procedure performed in sub-Saharan Africa (SSA), accounting for as much as 80% of the surgical workload. In contrast to CSs performed in high-income countries, CSs performed in SSA are accompanied by high morbidity and mortality rates. This operation is the most important known variable associated with an increased probability of postpartum bacterial infection. The objective of this review was to assess surgical outcomes related to CS in SSA. PubMed (including Medline), CINAHL, Embase, and the World Health Organization's Global Health Library were searched without date or language restrictions. A total of 26 studies reporting surgical site–infection rates after CS were identified, representing 14,063 women from 14 countries. The vast majority (76.7%) of CSs performed were emergency operations. The overall CS rate for women included in this review was 12.4% (range: 1.0%–41.9%). Only 17 of 26 total studies reported a significant proportion of women receiving antimicrobials of any kind. The surgical site–infection rate was 15.6% and the wound-infection rate 10.3%.

Keywords: cesarean section, maternal mortality, surgical site infection, wound infection, sepsis, sub-Saharan Africa

Introduction

The 45% decline in global maternal deaths from 1990 to 2013[1] is a deceptively rosy statistic that obscures the vast discrepancy between current morbidity and mortality rates in high- and low- to middle-income countries. The maternal mortality ratio in developing regions of the world is 14 times greater than in developed regions, and countries in sub-Saharan Africa (SSA) remain the most gravely impacted.[1] Therefore, maternal and neonatal health remains a crucial field of concern in global health, particularly because the elevated incidence of maternal morbidity and mortality in low- and middle-income countries is largely preventable.[1]

Cesarean section (CS) delivery is one of the most common operative procedures performed in SSA, accounting for as much as 80% of the surgical workload.[2,3] In contrast to CS performed in high-income countries, CSs performed in SSA are primarily emergency operations and accompanied by high morbidity and mortality rates.[4] This operation is the most important known variable associated with an increased probability of postpartum bacterial infection when compared with vaginal birth, with reported rates of infection ranging from 1% to 25%, about 5 to 20 times higher than that of vaginal delivery.[5] In addition to the physical consequences associated with postpartum bacterial infection, such as maternal infirmity and neonatal mortality, these infections often share a common pathophysiological pathway with fetal and neonatal infections and death, thereby contributing to the significant social costs stemming from maternal illness.

Correspondence: Angie Sway
World Surgical Infection Society,
7800 Cooper Road – suite 207,
Cincinnati, Ohio 45242, USA
Tel +1 562 287 9199
Email asway@worldsis.org

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Surgical site infections (SSIs) are an important global cause of morbidity and mortality in patients undergoing all types of operations. These infections lead to increased duration of hospitalization, health care costs, morbidity, and risk of death. Recent systematic reviews from the World Health Organization (WHO) have highlighted particularly high SSI rates in SSA.[6,7] However, since these rates are derived from a mix of operative procedures, the true rate of SSI following CS is not clear, but is likely greater.

CS is of particular interest as an index procedure for SSI modeling and assessment of interventions because many of the complicating factors that may obscure the true cause of infection are not present: the surgical technique is standardized and the operation generally performed on younger women who do not suffer from the disease- and age-related risks of infection and comorbidities seen in broader surgical surveys.

The objective of this review is to create a picture of recent surgical outcomes related to CS in SSA. While there have been single- and multiple-country studies on maternal health for this region, there has been no attempt to synthesize the information across all of the countries in SSA. This kind of region- and procedure-specific information may allow for more precise design and implementation of guidelines being developed for maternal sepsis and prevention of post-CS SSIs, and can then be used by policymakers, hospital administrators, and health care workers to identify areas for improvement.

Methods

We conducted a review of studies on the incidence and epidemiology of SSI following CS in SSA. PubMed (including Medline), CINAHL, Embase, and the WHO's Global Health Library were searched using the terms: ("surgical wound infection" [MeSH] OR surgical site infection* [TIAB] OR "SSI" OR "SSIs" OR surgical wound infection* [TIAB] OR surgical infection* [TIAB] OR post-operative wound infection* [TIAB] OR postoperative wound infection* [TIAB] OR wound infection* [TIAB] OR (("preoperative care" [MeSH] OR "preoperative care" OR "pre-operative care" OR "perioperative care" [MeSH] OR "perioperative care" OR "peri-operative care" OR perioperative OR intraoperative OR "perioperative period" [MeSH] OR "intraoperative period" [MeSH]) AND ("infection" [MeSH] OR infection [TIAB]))) AND (((((((("cesarean childbirth") OR "cesarean complications") OR "cesarean delivery complications") OR "cesarean infections") OR cesarean) OR cesarean)) AND (("surgical wound infection" [MeSH] OR surgical site infection* [TIAB] OR "SSI" OR "SSIs" OR surgical wound infection* [TIAB] OR surgical infection* [TIAB] OR post-operative wound infection* [TIAB] OR postoperative wound infection* [TIAB] OR wound infection* [TIAB] OR (("preoperative care" [MeSH] OR "preoperative care" OR "pre-operative care" OR "Perioperative Care" [MeSH] OR "perioperative care" OR "peri-operative care" OR perioperative OR intraoperative OR "perioperative period" [MeSH] OR "intraoperative period" [MeSH]) AND ("infection" [MeSH] OR infection [TIAB])))))) AND ("Africa south of the Sahara" OR "sub Saharan Africa").

This search was also completed separately with individual names of countries in SSA specified by the Library of Congress. We applied the same search strategy to the Cochrane database to identify any published reviews and included references. No date restrictions were used in the search. Prospective, randomized trials were excluded, in order to eliminate studies with eligibility criteria that excluded women with conditions considered to be risk factors for SSI, as this might have confounded our analyses. References from the eligible studies were reviewed to identify additional studies.

All results from the search were independently screened, reviewed, and analyzed. Two research associates performed three levels of screening: title, abstract, and full text. Full-text articles of relevant studies were obtained and analyzed for content. Extracted data included authors, year of publication, country or countries where the study was done, study period, study setting, study population size, indications for CS, potential risk factors, reported infection prevalence or cumulative incidence data, wound-contamination class and type of SSI, antibiotic prophylaxis, and microbial isolates (if studied). Institutional review board approval was not necessary, as this was a review of previously published studies, all of which had obtained approval.

Quality assessment

To allow comparisons between individual studies, evaluate the quality of conclusions drawn from individual studies, and identify reporting gaps, we created a quality-scoring system for this review, modified from others of similar utility.[8,9] The system we developed awarded one point for the reporting of each of the ten factors: study type, study dates, description of study site, HIV status, antiretroviral therapy status, preeclampsia/hypertension, antenatal care status, rupture of membranes, meconium staining, and chorioamnionitis. The same scoring system was used for the reporting of 15 operative and outcome variables: repeat CS, emergency or elective operation, cephalopelvic disproportion (CPD) or obstructed labor, fetal distress, hemorrhage, breech, type of antibiotic administered, timing of antibiotic administration, duration of operation, length of stay, Centers for Disease Control and Prevention (CDC) SSI type, endometritis, maternal death, fetal death, and duration of follow-up. The total number of categories was thus 25. As such, the rating for each could range from 0 (lowest quality) to 25 points (highest quality).

Where similar scoring systems have used categories chosen to evaluate the quality of study management and performance, our modified system is focused on evaluating how widely certain factors were reported. Investigators chose the included categories for their importance in understanding factors contributing to SSI: certain patient and operational variables are well known to increase the risk of infection, and certain definitional categories are useful in understanding the type of infection encountered.[12,13] We believe that these categories outline the minimum information needed to clearly define the circumstances surrounding and leading to SSI.

Results

A total of 26 studies[10–35] reporting SSI rates after CS were included in this review, representing procedures conducted on 14,063 women from 14 countries in SSA. Table 1 outlines the general characteristics of the eligible studies. In sum, 22 of these studies were conducted at academic and/or urban hospitals, the majority of which served as urban referral centers for smaller health care facilities. The mean city population for the hospitals was 2,376,486 with a range of 7,966–16,060,303. All eligible studies were observational. Quality scores for each study are also shown in this table. Scores ranged from 4 to 16 of a maximum of 25. Almost all studies reported the study type, study dates, and type of facility. Repeat CS, emergency or elective surgery, CPD and/or obstructed labor, and fetal distress were the most widely reported categories.

Table 2 shows background demographic information for the included studies and hospitals. The vast majority (76.7%) of CSs performed were emergency operations. The lowest rate of emergency CSs was 26.7% and the highest 100.0%. It was also reported that many of the hospitals saw a high number of births per year (mean 16,752, range 274–174,561), as well as a high ratio of CSs to vaginal births. The overall CS rate for women included in this review was 12.4% with a range of 1.0%–1.9%.

As shown in Table 3, the most significant indication for CS in this population was CPD and/or obstructed labor (40.4%), followed by repeat CS (19.6%), fetal distress (13.0%), prolonged rupture of membranes (7.7%), breech and/or malpresentation (7.7%), eclampsia (6.6%), hemorrhage (6.3%), and cord prolapse (3.7%). CPD is likely accompanied by prolonged ruptured amniotic membranes and thus becomes a marker for contaminated procedures. Prevalence ranged 8.1%–76.9% in CPD/obstructed labor, 6.4%–44.4% for repeat CS, 2.9%–36.1% in fetal distress, 0.7%–64.9% in prolonged rupture of membranes, 3.0%–13.1% in breech and/or malpresentation, 0.6%–18.8% in preeclampsia/hypertension, 1.4%–14.4% in hemorrhage, and 1.4%–17.5% in cord prolapse.

Table 4 details the administration of antibiotics, widely considered a key strategy for the prevention of SSI. Only 17 of 26 total studies reported a significant proportion of women receiving antimicrobials of any kind, and only eleven studies of those 17 reported the exact antibiotic or combination of antibiotics used. There was no uniformity in either the medication given or the timing (preoperative vs postoperative) across the studies.

Table 5 shows the reported infectious complications categorized by definitions of infection used by the authors. Seven studies reported infection data based on standardized terminology given by the CDC. The SSI rate for these studies was 15.6%. The most widely reported SSI category, wound infection, had a cumulative incidence of 10.3%.

Discussion

Efforts to reduce maternal mortality and morbidity must focus not only on expanding the quantity and availability of care but also on improving the quality of existing health care. In order to move forward with the second goal, there must be clear and accurate understanding of the current quality of care. Single-center audits are of considerable importance for both the local population and the larger population, because they can suggest improvements in reporting standards and quality of care. Given the high rates of infection, it is vital to understand past and current experiences in local health care centers in order to tailor a solution built on a foundation of good evidence. Reviews that synthesize the entire field of information are a powerful tool that can illuminate key areas for high-impact intervention and the data gaps that should be addressed.[8,36]

The purpose of this review was to provide information on reported infection rates following CS in SSA. We found rates of infection ranging from 10.3% to 15.6%, many times greater than those in high-income countries, such as the US. Furthermore, the duration of follow-up was <30 days in at least three studies, suggesting that SSI rates may have been underreported. This review also reinforced the notion that nearly all CSs in SSA are performed as emergency operations.

Table 1 Study characteristics

Study	Year	Study period (month/year)	Country	Hospital type	Hospital city	City population (n)	Hospital county	Study population (n)	Quality score (n/25)
Adesunkanmi and Faleyimu[10]	2003	1/1989–12/1993	Nigeria	Academic	Ilesa	647,500	Osun	701	13
Ali[11]	1995	6/1992–9/1993	Ethiopia	Academic	Jimma	207,573	Jimma	100	12
Amenu et al[12]	2011	4/2009–3/2010	Ethiopia	Academic	Jimma	207,573	Jimma	580	10
Ansaloni et al[13]	2001	3/1997–7/1997	Kenya	Rural	Kiambu	88,869	Kiambu	160	13
Björklund et al[14]	2005	7/2001–1/2003	Uganda	Urban tertiary	Kampala	1,659,600	Kampala	1,526	16
Brisibe et al[15]	2015	NA	Nigeria	Academic	Port Harcourt	2,000,000	Rivers	711	4
Bukar et al[16]	2009	1/2001–12/2003	Nigeria	Federal	Gombe	2,353,000	Gombe	250	11
Chilopora et al[17]	2007	10/2005–12/2005	Malawi	Multicenter	NA	NA	NA	1,754	13
Chu et al[18]	2015	8/2010–1/2011	Burundi, Democratic Republic of the Congo, Sierra Leone	Multicenter	Masisi, Lubutu, Kabezi, Bo	NA	North Kivu Province, Maniema, Bujumbura, Southern Province	1,276	15
de Nardo et al[19]	2016	8/2013–11/2013	Tanzania	NA	Dodoma	410,956	Dodoma	467	11
Ezechi et al[20]	2009	1/2004–8/2008	Nigeria	Urban	Lagos	16,060,303	Lagos	817	7
Fesseha et al[21]	2011	1/2008–12/2008	Ethiopia	Mixed	NA	NA	NA	267	12
Harfouche et al[22]	2015	1/2010–6/2010	Malawi	District	Lilongwe	1,077,116	Central Region	513	11
Jido and Garba[23]	2012	1/2001–12/2002	Nigeria	Academic	Kano	3,333,300	Kano	485	12
Johnson and Buchmann[24]	2012	7/2010–8/2010	South Africa	Academic	Johannesburg	4,434,817	Gauteng	272	8
Koigi-Kamau et al[25]	2005	1/2001–4/2001	Kenya	District	Kiambu	88,869	Kiambu	153	7
Moodliar et al[26]	2007	11/2003–1/2004	South Africa	Academic	Durban	3,442,361	KwaZulu-Natal	737	13
Moran et al[27]	1999	NA	Ghana	Rural	Techiman	104,212	Brong Ahafo	100	10
Morhason-Bello et al[28]	2009	7/2004–9/2004	Nigeria	Academic	Ibadan	3,034,200	Oyo	74	7
Mpogoro et al[29]	2014	10/2011–2/2012	Tanzania	Academic	Mwanza	2,772,509	Mwanza	345	15
Ojiyi et al[30]	2012	6/2004–5/2008	Nigeria	Academic	Orlu	420,000	Imo	385	10
Rabiu et al[31]	2011	1/2008–12/2009	Nigeria	Academic	Lagos	16,060,303	Lagos	347	9
Saxer et al[32]	2009	12/2003–3/2004	Tanzania	District	Ifakara	99,000	Morogoro	803	8
Sekirime and Lule[33]	2008	NA	Uganda	Academic	Kampala	1,659,600	Kampala	500	11
van Bogaert and Misra[34]	2009	NA	South Africa	Public	Glen Cowie	7,966	Limpopo	692	6
Zvandasara et al[35]	2007	6/2006–8/2006	Kenya	Academic	Harare	1,619,000	Harare	546	12

Abbreviation: NA, not available.

Table 2 Background

Study	Hospital births per year, n	Hospital cesareans per year, n (% of total births)	Elective, n (%)	Emergency, n (%)	HIV+, n (%)
Adesunkanmi and Faleyimu[10]	NA	NA	86 (12.3)	615 (87.7)	NA
Ali[11]	1,236	100 (8.1)	8 (8.0)	92 (91.6)	NA
Amenu et al[12]	NA	NA	23 (4.0)	557 (96.0)	NA
Ansaloni et al[13]	3,072	242 (7.9)	76 (47.5)	84 (52.5)	NA
Björklund et al[14]	27,000	5,400 (20.0)	34 (2.2)	1,492 (97.8)	96 (6.3)
Brisibe et al[15]	NA	NA	NA	NA	NA
Bukar et al[16]	724	88 (12.2)	69 (27.6)	180 (72.0)	NA
Chilopora et al[17]	NA	NA	452 (25.8)	1,302 (74.4)	NA
Chu et al[18]	NA	NA	47 (3.7)	1,229 (96.3)	NA
de Nardo et al[19]	NA	NA	42 (9.0)	425 (91.0)	NA
Ezechi et al[20]	NA	NA	599 (73.3)	218 (26.7)	NA
Fesseha et al[21]	174,561	17,145 (9.8)	56 (21.0)	205 (76.8)	NA
Harfouche et al[22]	14,780	2,052 (13.9)	0	513 (100)	76 (14.8)
Jido and Garba[23]	3,162	320 (10.1)	51 (10.5)	434 (89.5)	NA
Johnson and Buchmann[24]	NA	NA	53 (19.5)	219 (80.5)	NA
Koigi-Kamau et al[25]	7,892	612 (7.8)	11 (7.2)	141 (92.2)	13 (8.5)
Moodliar et al[26]	2,126	744 (35.0)	112 (15.2)	625 (84.8)	NA
Moran et al[27]	10,000	100 (1.0)	0	100 (100)	NA
Morhason-Bello et al[28]	1,024	296 (28.9)	13 (17.6)	61 (82.4)	NA
Mpogoro et al[29]	2,444	559 (22.9)	26 (7.5)	319 (92.5)	NA
Ojiyi et al[30]	274	91 (33.2)	166 (46.4)	192 (53.6)	NA
Rabiu et al[31]	3,569	1,531 (42.9)	NA	NA	NA
Saxer et al[32]	NA	NA	35 (10.5)	297 (89.5)	NA
Sekirime and Lule[33]	NA	NA	0	500 (100)	NA
van Bogaert and Misra[34]	4,800	864 (18.0)	189 (27.3)	503 (72.7)	NA
Zvandasara et al[35]	11,377	2,297 (20.2)	130 (23.8)	414 (75.8)	NA

Abbreviation: NA, not available.

Our review also found CS rates of 1%–42.9%, outstripping the WHO recommendation for the optimal rate of CS, which ranges from 5% to 15% of total births.[37,38] CS rates have been increasing globally,[38] suggesting that the population at risk of SSI following CS in SSA will grow. In the developing world, Africa has seen the fastest pace of urban growth per year for the last 20 years (3.5%), and this rate is projected to hold steady until at least 2050. SSA is also projected to experience a faster-than-average rate of urbanization, growing from 40% of the population living in urban areas in 2014 to 56% by 2050.[39] Because the facilities that offer and perform CSs are predominantly located in urban areas, they will likely have to contend with the rise in the population served. Structural and resource-based barriers to high-quality maternal health care will become more pronounced and more damaging without timely and effective intervention. Other factors that may lead to an increase in CS rates are increases in the number of theater facilities, increases in the number of surgeons, increased monitoring of labor, and the shifting trend from home deliveries to hospital deliveries.

Limitations of data

A few limiting factors were encountered while conducting this review, most of which stemmed from limitations in individual studies. We could not capture studies or audits that were not published and/or archived, because our search was confined to databases of published studies. Internal facility reviews or audits done in smaller or more rural health care centers may not have been accessed if they were not published or uploaded to an electronic database. Additionally, the studies included in this review were nearly all from large centers located in urban areas, which likely have access to greater resources than smaller and more rural facilities. Our data thus

Table 3 Indications for CS

Study	Population, N	Prior CS, n (%)	PROMs, n (%)	CPD/obstructed labor, n (%)	Failed induction, n (%)	Fetal distress, n (%)	Hemorrhage, n (%)	Breech/ malpresentation, n (%)	Eclampsia/ Htn, n (%)	Cord prolapse, n (%)
Adesunkanmi and Faleyimu[10]	701	115 (16.4)	10 (1.4)	182 (26)	21 (3)	49 (7)	85 (12.1)	140 (20.0)	22 (3.1)	18 (2.6)
Ali[11]	100	16 (16)		44 (44)		6 (6)	8 (8)	21 (21)	1 (1)	
Amenu et al[12]	580		15 (2.6)							
Ansaloni et al[13]	160	71 (44.4)		47 (29.4)	16 (10)	28 (17.5)		28 (17.5)		28 (17.5)
Björklund et al[14]	1,526									
Brisibe et al[15]	711	201 (13.2)		809 (53.0)		150 (9.8)	70 (4.6)	84 (5.5)	103 (6.7)	
Bukar et al[16]	250									15 (2.1)
Chilopora et al[17]	1,754	18 (7.2)		52 (20.8)		22 (8.8)	36 (14.4)		47 (18.8)	
Chu et al[18]	1,276	452 (25.8)		1,290 (73.5)	60 (3.4)	264 (15.1)	77 (4.4)	53 (3.0)	49 (2.8)	62 (3.5)
de Nardo et al[19]	467	184 (14.4)	287 (22.5)	399 (31.3)		128 (10.0)	101 (7.9)		31 (2.4)	39 (3.1)
Ezechi et al[20]	817	166 (35.5)	11 (2.4)	81 (17.3)						
Fesseha et al[21]	267	158 (19.3)	62 (7.6)							
Harfouche et al[22]	513	29 (10.9)	2 (0.7)	86 (32.2)	8 (3.0)	38 (14.2)	17 (6.4)	35 (13.1)	15 (5.6)	6 (2.2)
Jido and Garba[23]	485	125 (24.4)		113 (26.7)		92 (17.9)		48 (9.4)		
Johnson and Buchmann[24]	272	100								
Koigi-Kamau et al[25]	153	31 (6.4)	7 (1.4)	86 (17.7)	24 (4.9)	19 (3.9)	7 (1.4)	48 (9.9)	67 (13.8)	7 (1.4)
Moodliar et al[26]	737	90 (33.1)	19 (7.0)							
Moran et al[27]	100		29 (19.0)							
Morhason-Bello et al[28]	74	101 (13.8)	3 (0.4)	154 (20.9)		266 (36.1)	35 (4.7)	28 (3.8)	120 (16.3)	
Mpogoro et al[29]	345	22 (22)		31 (31)		2 (2)	13 (13)	9 (9)	2 (2)	5 (5)
Ojiyi et al[30]	385		48 (64.9)							
Rabiu et al[31]	347	106 (30.7)	7 (2)	28 (8.1)		54 (15.7)	9 (2.6)	32 (9.3)	30 (8.7)	
Saxer et al[32]	803	43 (12)		54 (15.1)		38 (10.6)	44 (12.3)			34 (9.5)
Sekirime and Lule[33]	500			267 (76.9)		68 (19.6)				
van Bogaert and Misra[34]	692									
Zvandasara et al[35]	546		7 (1.5)	237 (49.6)		14 (2.9)	26 (5.4)	8 (1.7)	3 (0.6)	16 (3.3)
van Bogaert and Misra[34]		156 (22.5)								
Zvandasara et al[35]		139 (22.5)	48 (8.8)			16 (9.3)		63 (11.5)	72 (13.2)	

Notes: Values in parentheses show percentage of total births. Blank cells represent data not reported in the studies.
Abbreviations: CS, cesarean section; PROMs, prolonged rupture of membranes; CPD, cephalopelvic disproportion; Htn, hypertension.

Table 4 Perioperative factors

Study	Patients receiving antibiotics, n (%)	Antibiotic(s) used	Timing of antibiotics
Adesunkanmi and Faleyimu[10]	NA	NA	NA
Ali[11]	Most operated cases	NA	NA
Amenu et al[12]	NA	NA	NA
Ansaloni et al[13]	160 (100.0)	Single-dose ampicillin 3 g–metronidazole 500 mg IV	Immediately before operation
Björklund et al[14]	1,495 (98.0)	Benzyl penicillin G	Preoperative, n (%): 346 (22.7) Postoperative, n (%): 1,149 (75.3)
Brisibe et al[15]	0	None	None
Bukar et al[16]	250 (100.0)	NA	NA
Chilopora et al[17]	1,140 (65.0)	NA	Preoperative
Chu et al[18]	1,276 (100.0)	Cefazolin 1 g	Preoperative
de Nardo et al[19]	460 (99.0)	Ceftriaxone–metronidazole + ampicillin–cloxacillin	Preoperative, n: 10 Postoperative, n: 450
Ezechi et al[20]	NA	NA	NA
Fesseha et al[21]	251 (94.0)	NA	NA
Harfouche et al[22]	424 (82.6)	Chloramphenicol or penicillin or ceftriaxone	NA
Jido and Garba[23]	NA	NA	NA
Johnson and Buchmann[24]	NA	NA	NA
Koigi-Kamau et al[25]	NA	NA	NA
Moodliar et al[26]	725 (98.0)	NA	NA
Moran et al[27]	NA	NA	NA
Morhason-Bello et al[28]	74 (100.0)	NA	NA
Mpogoro et al[29]	344 (99.7)	Single-dose ampicillin or nonampicillin combination	NA
Ojiyi et al[30]	358 (100.0)	Ampicillin–cloxacillin or metronidazole–gentamicin	Preoperative
Rabiu et al[31]	NA	NA	NA
Saxer et al[32]	524 (99.0)	Chloramphenicol, aminopenicillin, benzylpenicillin	Preoperative, n (%): 63 (12.0) Postoperative, n (%): 461 (88.0)
Sekirime and Lule[33]	478 (100.0)	Penicillin	Postoperative
van Bogaert and Misra[34]	692 (100.0)	Ceftriaxone 1 g IV	Post–cord clamping
Zvandasara et al[35]	546 (100.0)	Penicillin–chloramphenicol	Preoperative

Note: Values in parentheses show percentage of total births.
Abbreviation: NA, not available.

cannot be said to be representative of the process of care or SSI rates seen at rural or smaller facilities.

A major limitation was the lack of standardized reporting across the included studies. None of the studies used identical reporting forms, and few used standard definitions for indications and infectious complication, such as SSI, endometritis, or chorioamnionitis. Seven of 26 stated that the CDC criteria for SSI were used, 18 studies used the term "wound infection" often without a specific definition, and one designated "sepsis" to describe post-CS SSI. Without corresponding diagnostic definitions, it is difficult to compare the results of individual studies. Finally, the low number of studies found was in itself a limitation, particularly given the broad search parameters. Only 26 studies representing 14 countries from a total of 52 countries in SSA were found, indicating a need for more extensive reporting.

Recommendations

One category of concern highlighted by the results of this review is a relatively clear-cut and cost-effective measure: the proper administration of antibiotics. The effectiveness of antibiotic prophylaxis when administered 120 minutes or less before skin incision is established and very widely accepted.[40] Broad acceptance of the use of antibiotics is reinforced by the results of this review, but there was a wide range at the time of administration, when reported. With strong evidence

Table 5 Postoperative complications

Study	Population, N	SSI*, n (%)	Superficial, n (%)	Deep, n (%)	Organ/space, n (%)	Wound infection, n (%)	Sepsis/febrile morbidity, n (%)	Endometritis, n (%)	Maternal death, n (%)	Perinatal death or stillbirth, n (%)	Follow-up (days), n
Adesunkanmi and Faleyimu[10]	701					138 (19.7)	115 (16.4)			15 (2.1)	
Ali[11]	100					27 (27.0)	21 (21.0)	33 (33.0)			
Amenu et al[12]	580	66 (11.4)									
Ansaloni et al[13]	160					21 (13.1)	7 (4.4)			10 (6.3)	42
Björklund et al[14]	1,526					99 (6.5)		170 (11.1)			
Brisibe et al[15]	711	96 (13.5)	26 (3.7)	44 (6.2)	26 (3.7)						
Bukar et al[16]	250					11 (4.4)	4 (1.6)		2 (0.8)	19 (7.6)	
Chilopora et al[17]	1,754					151 (8.6)	444 (25.3)		23 (1.3)	234 (13.3)	7
Chu et al[18]	1,276	93 (7.3)	85 (6.7)	7 (0.5)					7 (0.5)	174 (13.6)	
de Nardo et al[19]	467	225 (48.2)	138 (29.6)	69 (14.8)	5 (1.1)						30
Ezechi et al[20]	817					76 (9.3)					5
Fesseha et al[21]	267					20 (7.5)			2 (0.7)		
Harfouche et al[22]	513					1 (0.2)				63 (12.3)	
Jido and Garba[23]	485	44 (9.1)									
Johnson and Buchmann[24]	272					30 (11.0)	4 (1.5)				14
Koigi-Kamau et al[25]	153					29 (5.3)					
Moodliar et al[26]	737					39 (5.3)		19 (2.6)			
Moran et al[27]	100					25 (25.0)			4 (4.0)		
Morhason-Bello et al[28]	74					12 (16.2)					
Mpogoro et al[29]	345	34 (9.9)	21 (6.1)	8 (2.3)	5 (1.4)						30
Ojiyi et al[30]	385					41 (11.5)	30 (8.4)		3 (0.8)		
Rabiu et al[31]	347					47 (13.5)	69 (19.9)	9 (2.6)	3 (0.9)		
Saxer et al[32]	803	125 (23.7)	54 (10.2)	54 (10.2)	15 (2.8)				16 (3.0)		
Sekirime and Lule[33]	500					77 (16.1)					
van Bogaert and Misra[34]	692						51 (7.4)				
Zvandasara et al[35]	546					99 (18.1)	77 (14.1)	122			

Notes: *As per Centers for Disease Control and Prevention. Values in parentheses show percentage of total births. Blank cells represent data not reported in the studies. In this table, the included studies used varying definitions for SSI/wound infections, so it was not possible to aggregate data under one category/definition.
Abbreviation: SSI, surgical site infection.

suggesting that the efficacy of antibiotics drops off sharply when not given within this interval, there must be a focus on the surveillance, education, and enforcement of this policy.

A second recommendation would be for authors to use standardized definitions when reporting SSI risk factors and SSI types. The unusually wide variance found within such categories as CPD/obstructed labor and PROMs suggest that the study investigators used differing definitions or classifications, which makes it difficult to compile comparable data. Regional journals can also assist by ensuring that authors uphold standard definitions where such definitions exist, such as in the SSI field.

There has been extensive reporting that a prolonged period from onset of labor to CS is a major avoidable factor contributing to maternal and neonatal morbidity and mortality.[41] This delay can be broken into intervals, such as patient delay, transport delay, delay in care on admission to health care facility, and delayed operative delivery. Some factors contributing to delay are caused by cultural factors or lack of infrastructure, and will take greater time and resources to address. However, more short-term efforts may be focused on operative delays within facilities that are caused by the absence of a considered decision-making process. The current audit standard used is 30 minutes from decision to delivery in nonelective CS; however, it is unclear whether crossing this threshold truly represents a significant rise in the threat of maternal and fetal complications. Our third recommendation would be for quantitative and qualitative data on timing and factors contributing to delay to be a standard part of future studies. Finding the most feasible and reasonable decision to incision time for the SSA region would contribute greatly to improving quality of care and reduce the costs of this delay to women and facilities.

The practical method we would most recommend is the criterion-based audit, which provide a logical framework for quality improvement by systematically measuring and assessing clinical practices against previously established and accepted criteria. Criterion-based audits establish region-specific criteria for good-quality care by performing systematic literature reviews, the results of which are assessed by a panel of regional and international experts to arrive at the final audit criteria. These criteria are used to determine current practices and innovate mechanisms to achieve quality improvement. The feasibility and effectiveness of criterion-based audits in developing countries has been shown,[42] and we believe that this will be an important tool in the improvement of health care and standardized reporting.

Conclusion

This review of surgical site infections following cesarean section in sub-Saharan Africa found an surgical site–infection rate of 15.6% and a wound-infection rate of 10.3%.

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Disclosure

The authors report no conflicts of interest in this work.

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