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Laboratory Confirmed Puerperal Sepsis and Associated Factors Among Post Delivery Women Admitted at Bugando Medical Centre, Sekou Toure and Sengerema Hospitals in Mwanza, Tanzania

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ABSTRACT

Background: Puerperal sepsis is one of the leading causes of preventable maternal morbidity and mortality. It accounts for about 11 % of maternal death worldwide, with highest prevalence being reported from low income countries. However, in Mwanza data on the proportion of post-delivery women with laboratory confirmed puerperal sepsis, bacterial patterns and associated factors were still limited. This is turn limits institution of specific antimicrobial therapies for this population.

Objective: To determine the proportion of laboratory confirmed puerperal sepsis, associated factors and bacterial patterns among post-delivery women with clinical features of puerperal sepsis admitted at BMC, SRRH and SDDH in Mwanza, Tanzania.

Methodology: A cross-sectional analytical hospital based study involving 340 post-delivery women admitted at BMC (152), SRRH(108) and SDDH (80) was conducted between October 2017 to April 2018.A structured pre-tested questionnaire was used to obtain socio- demographic, clinical and obstetric information from the participants. The endocervical swab and venous blood were aseptically taken for culture and antimicrobial susceptibility testing as per standard operating procedures. Data were analysed using STATA version 13 according to objectives of the study**.**

RESULTS; The mean age of the study participant was 26.2 ± 6.5 years. The proportion of laboratory confirmed puerperal sepsis was 58.8% (200/340). Of these, 164 (82%) had positive culture for endocervical swabs, 17 (8.5%) were blood culture positive and 19 (9.5%) had positive culture results

from both blood and endocervical swabs. *Staphylococcus aureus* were the most predominant bacteria isolate from blood culture 13 (36.1%), while the *Escherichia coli* 52 (26.0%) were the most predominant bacteria isolated from the endocervical swabs.
All *Staphylococcus aureus* (except one strain) were sensitive to gentamicin and vancomycin. Over three quarter of *E.coli* was resistance to ampicilin, trimethoprim-sulfamethoxazole, amoxicillin-clavulanate and ceftriaxone; and none of these were resistant to meropenem. *Acinetobacter* spp. were mostly multidrug resistance, with variable resistance to meropenem (0% to 20%).
On multivariable logistic regression analysis, primipara (OR: 10.14, 95%CI: 4.20-24.46, P<0.001), grand multipara OR: 3.85, 95%CI: 1.52-9.74, P=0.004, premature rupture of membrane with OR: 4.31, 95%CI: 1.61-11.47, P=0.003 , pre/eclampsia OR: 3.66, 95%CI: 1.7-11.40, P=0.025, anemia OR: 2.56, 95%CI: 1.20-5.79, P=0.018 and prolonged labor duration OR: 12.69, 95%CI: 5.7-28.0, P=<0.001 were found to be independent predictors of laboratory confirmed puerperal sepsis
CONCLUSION: Approximately 60% of women with clinical features of puerperal sepsis had laboratory confirmed puerperal sepsis, with *Staphylcococcus aureus* and *E. coli* being predominant bacteria species. High resistance to various agents among bacteria recovered calls for laboratory guided specific antimicrobial therapies to ensure favourable patients outcomes. Patients with premature rupture of membranes, prolonged duration of labours and co-morbid conditions such as anaemia and pre/eclamsia should be targets for preventive measures against puerperal sepsis.

Keywords: Puerperal Sepsis, Associated factors, bacterial pattern

Introduction

Puerperal sepsis is any infection of the female reproductive tract following childbirth within 42 days post delivery(1).The diagnosis of puerperal sepsis is usually based on clinical findings, such as fever, lower abdominal pain, offensive-smelling lochia, abnormal vaginal bleeding, and abnormal vaginal discharge(1, 2). If not timely treated, puerperal sepsis can lead to pelvic abscess, pelvic hematoma, peritonitis and may subsequent disseminate to the blood stream causing fatal maternal sepsis (1, 3-5). The magnitude of puerperal sepsis vary across the globe due to the differences in the socio-cultural factors related to health seeking behaviour, clinicians index of suspicious in making timely diagnosis and laboratory infrastructures for confirming the diagnosis and guide specific antimicrobial therapy (3). In 2013, 11% of maternal deaths worldwide were attributed to postpartum sepsis(6, 7). In south Asia puerperal sepsis contribute about 14% of the maternal deaths(1, 7, 8).Maternal death due to puerperal sepsis reported to be 21.68% in India and 8.5% in Pakistan(9).In Africa puerperal sepsis accountedfor 12%-34.8% of maternal death(10).Puerperal sepsis was also mentioned to be one of the leading cause of morbidity and mortality among post-delivery women at BMC in a retrospective review between 2008 and 2012 (11).The commonest pathogens causing puerperal sepsis are reported to be gram negative bacteria which account for 67.3% of cases while gram positive bacteria account for 32.6%(12, 13).The gram-positive bacteria mentioned to be involved includes *Staphylococcus* spp., *Streptococcus* spp., and Gram-negative bacteria like *Escherichia coli*, Klebsiella spp. and *Enterobacter* spp. Anaerobes like *Bacteroides* spp. and *Clostridium perfringes*. as well as agents of sexual transmitted infections like *Chlamydia* spp. and *Neisseria gonorrhoea*(12, 14-18). In Mwanza Tanzania, there was limited information regarding the factors associated with puerperal sepsis, common microorganisms and evidence-based antimicrobial agents to be used in treating these patients. This study has generated

information about the magnitude of the problem, its associating factors and antimicrobial susceptibility patterns of the pathogens implicated.

Methods

This was a cross section analytical study, conducted in the post-natal wards at BMC, SDDH and SRRH in Mwanza, Tanzania from October 2017 to April 2018. The study was carried out at department of obstetrics and gynaecology at BMC, SDDH and SRRH.BMC is a consultant/referral and teaching hospital for the Lake and Western zones of the United Republic of Tanzania. It is situated along the shores of Lake Victoria in Mwanza City; it has 947 bed capacity and approximately 900 employees, has approximately 600 numbers of deliveries per month in labour ward. It is a referral centre for tertiary specialist care for seven regions, including Mwanza, Mara, Kagera, Shinyanga, Simiyu, Tabora and Kigoma. It serves catchments population of approximately 13 million people. SRRH is a regional referral hospital located in Northern western part of Tanzania main land along the shores of the Lake Victoria in Mwanza city. It has 375bed capacity,11 wards with 406 health workers with different qualifications. It has approximately 700 numbers of deliveries per month in labour ward. It's catchment area include Nyamagana, Ilemela, Misungwi,Kwimba, Sengerema, Ukerewe, Buchosa and Magu with a population of 3,250,817.SDDH is located in a rural area and has an estimated population size of 663,034(38), has a bed capacity of 320 beds and approximately 746 deliveries in labour ward per month.This study included all women at their puerperal period admitted at BMC, SDDH and SRRH with clinical features of puerperal sepsis.Sample size of this study was calculated using Kish leslie (1965) formula for cross sectional studies (39). Using the prevalence of 30.4% from the previous study in Zambia(22), $N = \underline{Z^2\ P\ (1\text{-}P)}/D,^2$ where: Z= Z score for 95% confidence interval = 1.96, P = prevalence= 30.4%, D= tolerable error =5% which was 322 number of participants. Therefore, the study enrolled 340 (BMC-152, SRRH-108, SDDH 80) of women with clinical features of puerperal sepsis based on bed capacity of each facility. It included all women in the puerperal period who consented and had fever, abnormal vaginal discharge and lower abdominal pain, and/or delayed uterine involution regardless of mode and outcome of delivery .It excluded all women post delivery who underwent post caesarean-hysterectomy. Data collection technique was done by direct interview using structured pre-tested questionnaires were conducted to participants. The demographic and medical/obstetric information were collected through interview, from antenatal cards, patients files where the information like Socio-demographic characteristics such as: age, economic status, occupation, education, marital status and parity status; Obstetric factors including; parity, antenatal visits, place of delivery, mode of delivery, duration of labour, number of vaginal examinations, mode of placental delivery and presence or absence of other systemic diseases, HIV, Pre-Eclampsia, Eclampsia, Anaemia, PROM, stillbirths, emergency or elective caesarean section, perineal tears, use of antibiotics, and labor inductions. Sample collection, transportation and laboratory analysis. The endocervical swab using sterile Cusco speculum and blood samples were taken from women suspected to have puerperal sepsis. The swab was inserted into the Stuart transport media and capped. Approximately 5 – 8 mls of venous blood was aseptically collected from every patient into Brain-Heart Infusion broth. Samples were labelled and transported within 2 hours to the CUHAS Multipurpose Laboratory for culture and antimicrobial susceptibility testing. Swabs were inoculated into 5% Sheep blood agar and MacConkey agar then incubated aerobically at 35 - 37°C for 18 - 24 hours. Isolates identification to species level were done by conventional physiological and biochemical methods. These include grams stain, catalase reaction, coagulase reaction, haemolytic

activity on sheep blood agar plates, hippurate hydrolysis and CAMP tests for Gram-positive bacteria. In case of Gram negative bacteria, colonies morphology on MacConkey agar were described. Followed by biochemical tests such as triple sugar iron agar reaction, indole, motility, citrate, urease and hydrogen sulphide production as previously described(40).Drug susceptibility testing was done using a Kirby Bauer disk diffusion technique. Pure colonies from fresh culture were used to set a 0.5 McFarland standard and inoculated on the Muller Hinton agar. For gram positive bacteria penicillin G (10 U), ampicillin (10 µg), clindamycin (2 µg), erythromycin (15 µg), vancomycin (30 µg), ciprofloxacin (5 µg), and cefoxitin (30 µg) discs were tested. For gram negatives ampicillin (10 µg), amoxillin/clavulanic acid (20/10 µg), ciprofloxacin (5 µg), gentamicin (10 µg), trimethoprim/sulphamethaxazole (1.25/23.75 µg), ceftazidime (30 µg) ceftriaxone (30 µg) and meropenem (10 µg), was tested. The susceptibility testing results were interpreted following Clinical Laboratory Standard Institute (CLSI) guideline(41). Data were double entered, verified and cleaned and analysis was done using STATA version 13 according to objectives. Categorical data were described as proportion and were compared using chi square test or Fishers Exact Test while Continuous variables were compared using T- Test or Rank Sum Test, for symmetrically and asymmetrically distributed data respectively. Multivariate analysis was done using a logistic regression model to determine risk factors associated with puerperal sepsis. At 95% confidence intervals, a p-value of less than 0.05 will be considered significant. Data from questionnaires were reviewed daily by a principal investigator for completeness and consistence of responses. To ensure accuracy of data entry two data clerks were involved. Where discrepancies arise, the two data clerks were asked to solve the problem. Two laboratory technicians performed the tests. Laboratory procedure was done following standard operating procedures by experienced laboratory scientists under direct guidance of clinical microbiologists at CUHAS. Standard strains of *Escherichia coli*(ATCC 25922) and *Staphylococcus aureus* (ATCC 25923) were used as reference strains for quality control of definitive culture and antimicrobial susceptibility testing.

RESULTS

Demographic characteristic

A total of 340 postpartum women with clinical features of puerperal sepsis were recruited in this study from BMC 152 (44.7%), SRRH 108(32%) and SDDH80 (24%). The mean age ± standard deviation of study population was 26.2 ± 6.5 years. Majority were from rural areas 241(70.1%), married 311(91.5%) and primary school leavers 277 (81.5%) (Table. 1)

Tab 1.Distribution of socio demographic characteristics of patients enrolled.

Patients' characteristics	Number (n)	Percentage (%)
Mean age±SD (years)	26±6.5*	
Education		
Primary	277	81.5
Secondary	41	12.0
No formal education	22	6.5
Occupation		
Peasant	183	62.9
House wife	109	20.3
Small business	32	8.5

Employed	16	8.3
Residence		
Rural	241	70.9
Urban	99	29.1
Marital status		
Married	311	91.5
Single	29	8.5

*Continuous variable; SD: Standard deviation

Clinical and obstetric characteristics of patients

In this study majority of the participants were primipara 160(47.1%), attended first antenatal visit in the 2nd trimester 288 (84.7%) and attended for more than 4 times 192(56.5%). There were 76 (22.4%) who delivered at preterm. Most of the participants delivered by caesarean section 210 (61.8%) and had prolonged labor duration 224(65.9%) (Table2).

Table2. Clinical and obstetric characteristics of patients

Variable	Number (n)	Percentage (%)
Parity		
Primipara	160	47.1
Multipara	106	31.2
Grandmultipara	74	21.7
Antenatal clinic booking		
1st Trimester	28	8.2
2nd Trimester	288	84.7
3rd Trimester	24	7.1
Number of visit		
Once	12	3.5
Twice	36	10.6
Thrice	100	29.4
≥4	192	56.5
Gestation age at delivery		
Preterm	76	22.4
Term	249	73.2
Postterm	15	4.2
Mode of delivery		
Vaginal delivery	130	38.2
Caesarean section	210	61.8
Proportion of patients with various parameters		
Anaemia	130	38.2
History of malaria infection	46	13.5

History of urinary tract infection	114	33.5
Preeclampsia/Eclampsia	59	17.3
*Other comorbidity	12	3.6
Premature membrane rupture	64	18.2
Induced labor	30	8.8
Home delivery	5	1.5
Labor duration >12hours	222	65.9
Number of vaginal examination≥4	218	64.1
Prophylactic antibiotics not given	150	71.4

*HIV/AIDS 8, Diabetic mellitus 2 and pulmonary tuberculosis 2

Laboratory confirmed puerperal sepsis and bacterial species isolated

Of the 340 participants; 200 (58.8%) had a positive culture result for either endocervical swab or blood. Of the 200 post-delivery women who had positive culture results, 164 (82%) had positive culture for endocervical swabs, 17 (8.5%) were blood culture positive and 19 (9.5%) had positive culture results from both blood and endocervical swab. *Staphylococcus aureus* was the most predominant bacteria species from blood culture 13 (36.1%), while the *Escherichia coli* 52 (26.0%) was the most predominant bacteria species isolated from the endocervical swabs

(Figure 1 and Table 3).

Others; *Enterobacter aerogenes* (2),*Proteus mirabilis*(1),*Streptococcus* spp(1)

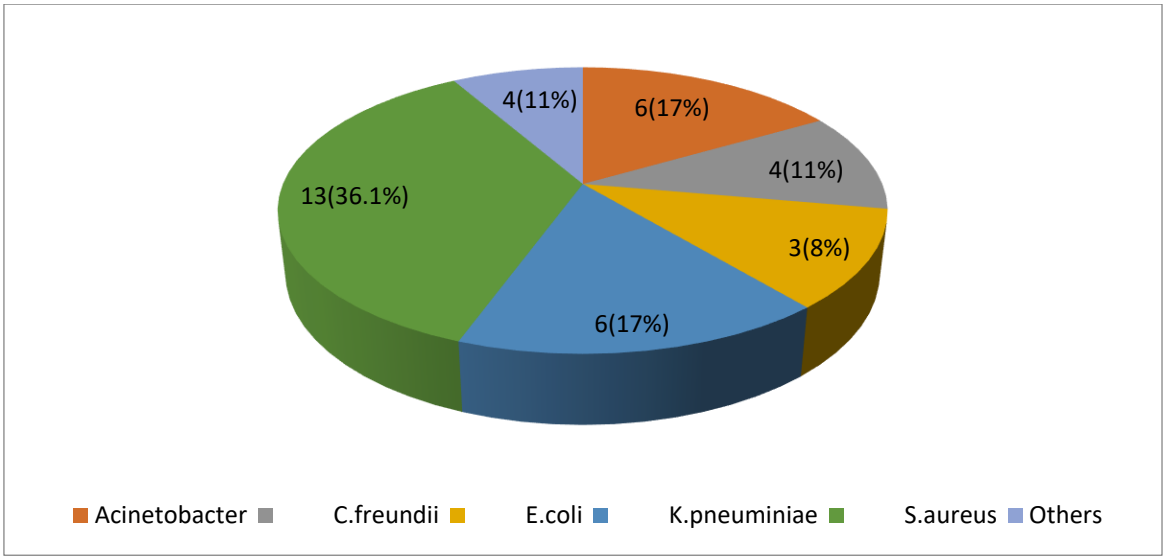

Figure 1: Bacteria species isolated from blood among patients with puerperal sepsis

Table 3. Bacteria species isolated from endocervical swabs among patients with puerperal sepsis

Bacteria	Number (n)	Percentage (%)
Escherichia coli	52	26.0
Acinetobacter species	40	20.0
Klebsiella pneumonia	37	19.0
Staphylococcus aureus	21	11.0
Klebsiella oxytoca	10	5.0

Citrobacter freundii	9	4.5
Morganella morganii	7	3.5
Enterobacter aereogenes	6	3.0
Pseudomonas aeruginosa	6	3.0
Serratia mercenses	4	2.0
Proteus vulgaris	2	1.0
Proteus mirabilis	2	1.0
Providecia species	1	0.5
Streptococcus viridians	1	0.5

Antibacterial resistance pattern for Gram negative bacteria isolated from blood
All *E.coli* and *Klebsiella* spp. were resistance to ampicilin, trimethoprim-sulfamethoxazole, amoxicillin-clavulanate and ceftriaxone; with all exhibiting ESBL phenotype. None of the *E.coli*, *Klebsiella* spp. and *Acinetobacter* spp. where resistance to meropenem (Table 4).

Table.4.Antibacterial resistance pattern for gram negative bacteria isolated from blood

BACTERIA NAME	AMP n(%)	SXT n(%)	GEN n(%)	CIP n(%)	AMC n(%)	CAZ n(%)	CTR n(%)	MEM n(%)	TZP n(%)	ESBL n(%)
Escherichia coli (n=3)	3(100)	3(100)	3(100)	2(66.67)	3(100)	3(100)	3(100)	0(0.00)	2(66.67)	3(100)
Klebsiella spp (n=6)	6(100)	6(100)	6(100)	2(33.33)	6(100)	6(100)	6(100)	0(0.00)	6(100.00)	6(100)
Acinetobacter spp(n=6)	NA	NA	2(33.33)	2(33.33)	NA	5(83.33)	5(83.33)	0(0.00)	5(83.33)	4(66.67)
Other GNB (7)	7(100)	6(85.71)	4(57.14)	2(28.57)	6(85.71)	6(85.71)	5(71.43)	0(0.00)	1(14.29)	6(85.71)

Other gram negative bacteria (GNB) (n=7) =*Citrobacter freundii (4), Enterobacter aerogenes (2) and Proteus mirabilis (1), NA =not applicable, ESBL*=Extended spectrum beta –lactamases producers
AMR=Ampicillin, SXT=Trimethoprim-sulfamethoxazole; GEN=Gentamicin; CIP= Ciprofloxacin; AMC= Amoxycillin-clavulanate; CAZ= Ceftazidime; CTR=Ceftriaxone; MEM= Meropenem; TZP=Piperacillin-tazobactum.

Antibacterial resistance pattern for Gram positive bacteria isolated from blood
All *Staphylococcus aureus* isolates were sensitive to vancomycin and gentamicin and 30.7% were methicillin resistant *Staphylococcus aureus* (MRSA). Also one *Streptococcus sp.* isolate was sensitive to gentamicin, clindamycin and vancomycin.

Antibacterial resistance pattern for Gram positive bacteria isolated from endocervix
None of the detected *Staphylococcus aureus* were resistant to ciprofloxacin and gentamicin, whereas, the resistance patterns to cefoxitin, vancomycin, clindamycin, and erythromycin were 1(4.7%), 1(4.7%), 9(42.9%) and 14(66.7%) respectively.

4.4.4. Antibacterial resistance pattern for Gram negative bacteria isolated from endocervix.

Of 52 *E.coli* detected, 29 (55.8%) were ESBL producers. The resistance pattern of the *E.coli* were 51(98.1%), 31(59.6%), 18(34.6%)and 0(0.0%)to ampicilin, Ceftriaxone, gentamicin, and meropenem, respectively. Of the 40 *Acinetobacter* spp. isolates, resistance to ciprofloxacin, Ceftriaxone and meropenem were 23(57.5%), 36(90.0%) and 8(20.0%), respectively (Table 6).

Table 6. Antibacterial resistance pattern for Gram negative bacteria isolated from endocervix

BACTERIA NAME	AMP n (%)	SXT n (%)	**AMC** n (%)	CAZ n (%)	CTR n (%)	GEN n (%)	CIP n (%)	MEM n (%)	ESBL n (%)
Escherichia coli(n=52)	51(98.07)	46(88.46)	48(92.3)	42(80.77)	31(59.62)	18(34.61)	22(42.31)	0(0.00)	29(55.76)
Acinetobacter (n=40)	NA	NA	NA	38(95)	36(90.00)	32(80)	23(57.50)	8(20.00)	34(91.89)
Klebsiella pneumonia (n=37)	35(94.59)	36(97.30)	37(100)	35(94.59)	33 (89.19)	31(83.78)	9(24.32)	3(8.11)	33(89.19)
Klebsiella oxytoca (n=10)	10(100)	10(100)	9(90)	9(90)	9(90)	4(40)	6(60)	0 (0.00)	7(70)
*Other GNB (n=37)	36(97.29)	36(97.29)	23(95.83)	30(81.08)	28(75.68)	15(40.54)	12(33.33)	5(13.51)	26(70.27)

*Other gram negative bacteria (GNR) (n=37) =*Citrobacter freundii (9),Morganellamorganii(7), Enterobacter aerogenes (6) , Proteus mirabilis (2), Proteus mirabilis(2) ,Pseudomonas aeruginosa (6),Serratia marcescens(4) Providencia species (1),* NA=not applicable

AMR=Ampicillin, SXT=Trimethoprim-sulfamethoxazole; GEN=Gentamicin; CIP= Ciprofloxacin; AMC= Amoxycillin-clavulanate; CAZ= Ceftazidime; CTR=Ceftriaxone; MEM= Meropenem; TZP=Piperacillin-tazobactum.

Morbidity, mortality and management of patients

Of 340 women, a total of 97(28.5%) women had peritonitis, while 32(9.4%) had bust abdomen. All patients were managed by antimicrobial therapies, intravenous fluid and 49(14.5%) underwent subtotal hysterectomy. A total of 8(2.4%) patients died, with six out of eight of these being para one (Table 7).

Table 7. Demographic, obstetric and clinical features among women who died

	Age (years)	**Marital status**	**Parity**	**PROM**	**PVE>4**	**Labor >12hours**	***Clinical presentation**	**Mode of delivery**	**Antibiotic use**	**Pre/ eclampsia**	**Anemia**	**Culture positive**	**Bacteria species**
1	20	Married	1	No	Yes	Yes	-	C/S	No	Yes	No	Yes	*Acinetobacter* sp
2	40	Married	6	No	Yes	Yes	Burst abdome	C/S	No	Yes	Yes	Yes	*E. aereoge*

							n						*nes*
3	20	Marr ied	1	Yes	Yes	Yes	Peritoni tis	SVD	N/A	Yes	Yes	No	N/A
4	26	Marr ied	1	No	Yes	Yes	-	C/S	No	Yes	Yes	Yes	*E. coli*
5	32	Marr ied	3	No	No	No	-	C/S	No	Yes	Yes	No	N/A
6	17	Marr ied	1	No	Yes	Yes	Peritoni tis	C/S	No	Yes	Yes	Yes	*C. freundii*
7	21	Marr ied	1	No	Yes	Yes	Peritoni tis	C/S	No	No	Yes	No	N/A
8	20	Marr ied	1	No	Yes	Yes	Peritoni tis	SVD	NA	Yes	Yes	Yes	*K.pneu moniae*

*Other clinical features apart from fever, lower abdominal pain and abnormal vaginal discharge, N/A=Not applicable, SVD=Spontaneous vaginal delivery, C/S=caesarean section

Risk factors associated with laboratory confirmed puerperal sepsis.

On univariate logistic regression analysis, premature rupture of membrane(OR: 2.7, 95%CI: 1.45-5.05, P=0.002), prolonged labor (1.10., 95%CI: 1.07-1.14, P=<0.001), deliver by caesarean section (OR: 2.46, 95%CI: 1.56-3.85, P=<0.001) and not getting antibiotics before caesarean section(OR: 3.32, 95%CI: 1.79-6.181, P=<0.001) were factors associated with culture positive for puerperal sepsis. On multivariable logistic regression analysis, primipara (OR: 10.14, 95%CI: 4.20-24.46, P<0.001),grand multipara OR: 3.85, 95%CI: 1.52-9.74, P=0.004, premature rupture of membrane with OR: 4.31, 95%CI: 1.61-11.47, P=0.003 , pre/eclampsia OR: 3.66, 95%CI: 1.7-11.40, P=0.025, anemia OR: 2.56, 95%CI: 1.20-5.79, P=0.018 and prolonged labor duration OR: 12.69, 95%CI: 5.7-28.0, P=<0.001 were found to be independent predictors of laboratory confirmed puerperal sepsis (Table 6).

Table6. Factors associated with puerperal sepsis among 200post delivery women

Variable	**Univariable**			**Multivariable**	
	Number (n) (%)	**OR(95%CI)**	**P value**	**OR(95%CI)**	**P**
Education					
No formal education	13(59.1)	1			
Primary	160(57.7)	0.94(0.39-2.28)	0.90	-	-
Secondary	27(65.9)	1.33(0.45-3.88)	0.59	-	-
Residence					
Urban(99)	57(57.5)	1			
Rural(241)	143(59.3)	1.08 (0.65-1.77)	0.76	-	-
Marital status					
Single(29)	20(69.0)	1			
Married(311)	180(57.9)	0.61(0.27-1.40)	0.25		

Parity					
Multipara (106)	29(27.4)	1			
Primipara(160)	132(82.5)	12.5(6.93-22.59)	<0.001	10.14(4.20-24.46)	<0.001
Grandmultipara(74)	39(52.7)	3.96(1.58-5.52)	0.001	3.85(1.52-9.7)	0.004
Nature of labor					
Spontaneous labor(310)	174(56.1)	1			
Induced labor (30)	26(86.7)	5.08(1.73-14.90)	0.003	6.34(1.52-26.32)	0.011
History of UTI					
NO(226)	117(51.8)	1			
YES(114)	83(72.8)	2.49(1.53-4.06)	<0.001	1.90(0.91-4.00)	0.105
Pre/Eclampsia					
NO (281)	151(53.7)	1			
YES(59)	49(83.0)	4.21(2.05-8.66)	<0.001	3.66(1.7-11.40)	0.025
PROM					
NO (276)	151(54.7)	1			
YES (64)	49(76.6)	2.70(1.45-5.05)	0.002	4.31(1.61-11.47)	0.003
Anaemia					
NO (130)	97(46.2)	1			
YES (210)	103(79.2)	0.33 (0.20-0.54)	<0.001	2.56(1.20-5.79)	0.018
Labor duration					
≤12hours(118) >12hours (222)	17(14.4) 183(82.4)	1 27.8(15.0-51.7)	<0.001	12.69(5.70-28.0)	<0.001
PVE* ≤4 (124)	31(25.0)	1			
>4 (216)	161(78.2)	10.7(6.41-18.10)	<0.001		
Mode of delivery					
Vagina(129)	59(45.4)	1			
Caesarean section(211)	141(67.1)	2.46(1.56-3.85)	<0.001	0.87(0.02-28.0)	0.93
****P/antibiotics**					
YES(62)	29(46.8)	1			
NO (149)	111(74.5)	3.32(1.79-6.18)	<0.001	0.99(0.99-1.00)	0.81

G/A=gestation age, ,UTI=urinary tract infection, C/S cesareansection,PROM=premature rupture of membrane,pre/eclapsia=preeclapsia/Eclampsia, * Not subjected to multivariate analysis because of colinearity with labor duration.**P/antibiotic=prophylactic antibiotic to those only who had cesarean section

DISCUSION

Demographic characteristics

Puerperal sepsis, a genital tract infection occurring from time of onset of labour or rupture of membranes

to 42 days postpartum, has been associated with maternal comorbidity and mortality (1, 7, 23) . In this study the mean age of study participants was 26.2 ± 6.45 years. This age correlates with the age group at risk found in other previous studies done in Pakistan, Uganda and Bangladesh (4, 19, 22, 42). Puerperal sepsis is known to be common among women with low education level dwelling in the rural areas (19, 25, 43). Similarly, in the current study, majority of the studied women were primary school leavers and peasants living in rural areas.

Laboratory confirmed puerperal sepsis and bacterial species isolated.

In the current study about 1 in 2 of women with clinical features suggestive of puerperal sepsis had culture positive results. This is higher compared to the study conducted in Zambia, Bangladesh, and Liquart University (2, 4, 43)which reported approximately 10% to 34.8% of clinically diagnosed puerperal sepsis. The difference can be due to the fact that the current study reported laboratory confirmed puerperal sepsis among women with clinical features of puerperal sepsis while previous studies reported the prevalence obtained from the clinical diagnosis of puerperal sepsis connoting the added value of the current study. The study conducted in India showed majority of vaginal swab culture from women with puerperal sepsis had positive results(7, 18). In the current study 53.8% of endocervical swab results were positive. The Study in India showed much higher prevalence compared to the current study, which may be due to possible contamination of the vaginal swab by normal flora. Moreover, endocervical swab culture positivity may signify that some patients with puerperal sepsis were initially having localized infections in the uterus, which in turn disseminated to the blood stream.

In the current study *Staphylococcus aureus* and*Escherichia coli* were the most predominant bacteria species. The predominance of these pathogens has also been reported previously at BMC in approximately 28.6% and 25.0%, respectively(34). The predominance of *E.coli* in endocervical swab may related to the close proximity of the genital tract and perianal end of the gastrointestinal tract where it exist as normal flora and therefore easy for it to ascend and cause infection when the conditions are favorable. The predominance of *S. aureus* in blood may be also due to its high virulence power to invade the blood stream and cause infection(44). The study done in Nigeria, Uganda, Amsterdam, and Pakistan also showed similar results (8, 13, 45, 46) .

Risk factors associated with puerperal sepsis

In this study the following factors were strongly associated with puerperal sepsis; low parity, labour induction, co-morbid conditions such as preeclampsia/elampsia and anemia, premature rupture of membrane, and having multiple per vaginal examination.The finding of strong association among primiparous women was consistent with findings observed in another study (5). The high risk to primiparous may be associated with their young age in their first pregnancy, a situation which may also be associated with prolonged obstructed labor, high chance of delivering by caesarean section and poor hygiene. On the other hand, grand multiparous in the current study was also risk, but this is contrary to the study which reported only 5.4%%(5).Women who had history of labor induction in the current study were also associated with laboratory confirmed puerperal sepsis (p=0.003) compared to those who were not induced labor. The study done in Pakistan, Zambia and Uganda (4, 18, 24) reported similar results. This may be explained by the fact that induction of labor especially by mechanical method is associated with introduction of infection to the uterus through the genital system. In the present study premature rupture of membrane was an independent predictor of laboratory confirmed puerperal sepsis (p=0.003).

These finding were also shown by other studies that premature rupture of membrane were associated with puerperal sepsis (5, 9). The reason for this is due to high transmission of infection as a result of loss of the barrier component that was the fetal membrane and amniotic fluid which prevented the ascending infection from the genital region through the cervical canal to the uterus.

The current study also reported an increased association of puerperal sepsis 82.6%in women who had prolonged labor; similar to other studies (4, 5, 9, 18, 19). This may be due to the fact that an open cervix with ruptured membranes for prolonged period impairs natural mechanical barriers to ascending infection from vagina. Also, multiple vaginal examinations in the current study strongly found to be associated with laboratory confirmed puerperal sepsis ($p<0.001$). Corresponding results were also documented by other previous studies (8, 10). The reasons for this may be due to high contamination of the cervix and uterus by the micro organisms introduced by repeated vaginal examination.

In the present study it has been revealed that those who delivered by caesarean section were having more risk of getting puerperal sepsis comparing to those who delivered by vaginal method in univariate analysis ($p<0.001$).Other studies have also reported these relationship (4, 24, 25). The reason for this high risk of puerperal sepsis after caesarean section may be explained by the fact that many women undergoing caesarean section are the ones with history of prolonged labor and had multiple vaginal examinations as confirmed in the current study. Furthermore, as documented in the current study, majority of women who undergone caesarean session did not receive pre-operative antibiotics which increase the risk of infection. The emergency nature of the surgery could explain the missing of pre-operative antibiotics. Despite prompt management, eight patients died connoting the fatal outcome of puerperal sepsis and the need for timely intervention.

Antimicrobial susceptibility patterns of bacteria

The present studyhas shown that many bacterial isolates were multidrug resistance. Majority of *Escherichia coli* isolateswere resistant to ampicilin, trimethoprim-sulfamethoxazole,amoxyclavulinic acid,and ceftriaxone; and also displayed intermediate resistance to gentamicin and ciprofloxacin. Fortunately, all were sensitive to meropenem. These results are similar to previous study conducted among pregnant women with or without PROM (Kamugobe E thesis, 2016). Over three quarter of *K. pneumoniae* isolates were resistant to ampicilin, trimethoprim-sulfamethoxazole,amoxyclavulinic acid and ceftriaxone. These isolates had also variable resistance to ciprofloxacin (24.3% to 33%) and meropenem 0.0% to 8%.*Acinetobacter* spp.were mostly multidrug resistance, with variable resistance to meropenem (0% to 20%).These findings were also similar to previous studies(13, 28, 30, 31, 46). High resistance of *Acinetobacter species* reported in the present study may be due to the fact that these are the nosocomial microorganism, which in most cases they are exposed to multiple antibiotics used in the hospital settings which led multi antimicrobial resistance. In this study, all *Staphylococcus aureus* (except one strain) were sensitive to gentamicin and vancomycin; majority also displayed high sensitivity to ciprofloxacin; as opposed to erythromycin and clindamycin. The findings are similar to other previous studies(12, 28, 34, 46).In the light of these findings, gentamicin, ciprofloxacin or vancomycin for Gram positive bacteria; and gentamicin, ciprofloxacin and meropenem for Gram negatives may be judiciously chosen as the treatment of choices depending on the severity of the condition and laboratory results guidance.

The low resistance to gentamicin observed in the current study may be due to the fact this drug is used in combination with other drugs during treatment; whereas low resistance to meropenem may be related to

its high cost and therefore infrequently used.

List of abbreviations:

ANC , Antenatal clinic: AMR, Antimicrobial resistance: BMC, Bugando Medical Centre: CCT , Controlled Cord: Traction**:** CUHAS, Catholic University of Health and Allied Sciences: DM, Diabetic Mellitus: ELSCS, Elective Lower Segment caesarean Section: ESBL, Extended Spectrum Beta Lactamases: FSB, Fresh still birth: Hb, Haemoglobin: MDR, Multidrug Resistant: MRSA, Methicillin Resistant Staphylococcus Aureus: MSB,Macerated still birth: PPROM, Preterm premature rupture of membrane: PROM, Premature rupture of membrane: PVE, Per vagina examination: RRCH, Regional Reproductive and Child health: SDDH, Sengerema Designated District Hospital: SVD ,Spontaneous vagina delivery: SRRH ,Sekou Toure Regional Referral Hospital: TBA, Traditional birth attendant: WHO, World Health Organization.

Ethics approval and consent to participate

Clearance was sought from the joint CUHAS/BMC Ethics and Review committee (CREC). Permission for conducting research and publication was requested from relevant governmental and hospitals' authorities. An informed consent was requested from the participants after explaining the aims of the study. For literate women, the information were provided followed by a consent form which each participant was required to sign to signify her consent. For non- literate women, the consent information sheet were read in full and participants required to thumb print on the consent form to signify their acceptance to participate in the study. Explanation was made that participation was voluntary and those refused to participate were still entitled to the standard care provided to all women admitted in gynaecological wards. For women aged <18years, consent was sought from the parent or guardian for their participation in the study. Confidentiality were maintained by the researcher and ensured all the information was strictly handled confidentially. Those, whose laboratory results revealed puerperal sepsis, were managed according to the protocol of a respective hospital.

Availability of data and material

The dataset used and analyzed during the current survey is available from the corresponding author on reasonable request

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Authors' contributions

GAR and SR conceptualized and designed the study, supervised the data collection, analyzed the data, interpreted the results, and drafted the manuscript. JS,ED and MFM supervised and designed the study, interpreted the results, and drafted the manuscript. All authors read and approved the final manuscript.

References

1. Soper DE, Mead PB. Infections of the Female Pelvis in Mandell, Bennett, & Dolin: Principles and Practice of Infectious Diseases, 6th ed., 2005. Churchill Livingstone, An Imprint of Elsevier pp 1373-1376. 2005.
2. Tal FGCe. Williams Obstetrics 24th Edition pg 683 2014.
3. WHO. The prevention and management of puerperal infections: report of a technical working group, Geneva, 20-22 May 1992. 1995.
4. Bartlett L, Lefevre AE, Mir F, Soofi S, Arif S, Mitra DK, et al. The development and evaluation of a community-based clinical diagnosis tool and treatment regimen for postpartum sepsis in Bangladesh and Pakistan. Reproductive health. 2016;13(1):16.
5. Khaskheli M-N, Baloch S, Sheeba A. Risk factors and complications of puerperal sepsis at a tertiary healthcare centre. Pakistan journal of medical sciences. 2013;29(4):972.
6. Shamshad SS, Rauf B. Puerperal sepsis—still a major threat for parturient. J Ayub Med Coll Abbottabad. 2010;22(3):18-20.
7. AbouZahr C. Global burden of maternal death and disability. British medical bulletin. 2003;67(1):1-11.
8. Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS, Shackelford KA, Steiner C, Heuton KR, et al. Global, regional, and national levels and causes of maternal mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet (London, England). 2014;384(9947):980-1004.
9. Miller A. Review of the bacteriology of puerperal sepsis in resource-poor settings. 2006.
10. Bartlett L, Lefevre AE, Mir F, Soofi S, Arif S, Mitra D, et al. The development and evaluation of a community-based clinical diagnosis tool and treatment regimen for postpartum sepsis in Bangladesh and Pakistan. Reproductive health. 2016;13(1):1.

11. Madhudas C, Khurshid F, Sirichand P. Maternal Morbidity and Mortality Associated with Puerperal Sepsis. JLUMHS. 2011;10(03):121.
12. Friday O, Edoja O, Osasu A, Chinenye N, Cyril M, Lovney K, et al. Assessment of infection control practices in maternity units in Southern Nigeria. International Journal for Quality in Health Care. 2012;24(6):634-40.
13. Magoma M, Massinde A, Majinge C, Rumanyika R, Kihunrwa A, Gomodoka B. Maternal death reviews at Bugando hospital north-western Tanzania: a 2008–2012 retrospective analysis. BMC pregnancy and childbirth. 2015;15(1):333.
14. Tamboli SS, Tamboli SB, Shrikhande S. Puerperal sepsis: predominant organisms and their antibiotic sensitivity pattern. International Journal of Reproduction, Contraception, Obstetrics and Gynecology. 2017;5(3):762-5.
15. Bako B, Ibrahim U, Umar J, Zamo A. Microbial Isolates in Puerperal Sepsis and Their in vitro Antibiotic Sensitivity in North Eastern Nigeria. J Women's Health Care. 2012;1(107):2167-0420.1000.
16. Rosene K, Eschenbach DA, Tompkins L, Kenny GE, Watkins H. Polymicrobial early postpartum endometritis with facultative and anaerobic bacteria, genital mycoplasmas, and Chlamydia trachomatis: treatment with piperacillin or cefoxitin. Journal of Infectious Diseases. 1986;153(6):1028-37.
17. GILSTRAP III LC, CUNNINGHAM FG. The bacterial pathogenesis of infection following cesarean section. Obstetrics & Gynecology. 1979;53(5):545-9.
18. Qadri S, Sharma K, Siddiqui B, Ehsan A, Sherwani RK, Sultan A, et al. Microbial Profile in Females with Puerperal Sepsis: A Major Threat to Women s Health: Study at a Tertiary Health Care Centre. Int J Curr Microbiol App Sci. 2015:248-55.
19. Ahmed MI, Alsammani MA. Puerperal sepsis in a rural hospital in Sudan. Materia socio-medica. 2013;25(1):19.
20. Dare F, Bako A, Ezechi O. Puerperal sepsis: a preventable post-partum complication. Tropical Doctor. 1998;28(2):92-5.
21. Ngonzi J, Tornes YF, Mukasa PK, Salongo W, Kabakyenga J, Sezalio M, et al. Puerperal sepsis, the leading cause of maternal deaths at a Tertiary University Teaching Hospital in Uganda. BMC Pregnancy and Childbirth. 2016;16(1):207.
22. Tangcharoensathien V, Mills A, Palu T. Accelerating health equity: the key role of universal health coverage in the Sustainable Development Goals. BMC medicine. 2015;13(1):101.
23. Graham W, Woodd S, Byass P, Filippi V, Gon G, Virgo S, et al. Diversity and divergence: the dynamic burden of poor maternal health. The Lancet. 2016;388(10056):2164-75.
24. Vallely L, Ahmed Y, Murray SF. Postpartum maternal morbidity requiring hospital admission in Lusaka, Zambia–a descriptive study. BMC pregnancy and childbirth. 2005;5(1):1.
25. Font F, Gonzalez MA, Nathan R, Lwilla F, Kimario J, Tanner M, et al. Maternal mortality in a rural district of southeastern Tanzania: an application of the sisterhood method. International journal of Epidemiology. 2000;29(1):107-12.
26. GIBBS RS. Clinical risk factors for puerperal infection. Obstetrics & Gynecology. 1980;55(3):178S-83S.

27. Olsen MA, Butler AM, Willers DM, Gross GA, Devkota P, Fraser VJ. Risk factors for endometritis after low transverse cesarean delivery. Infection Control & Hospital Epidemiology. 2010;31(01):69-77.
28. Yokoe DS, Christiansen CL, Johnson R, Sands KE, Livingston J, Shtatland ES, et al. Epidemiology of and surveillance for postpartum infections. Emerging infectious diseases. 2001;7(5):837.
29. Manyahi J, Matee MI, Majigo M, Moyo S, Mshana SE, Lyamuya EF. Predominance of multi-drug resistant bacterial pathogens causing surgical site infections in Muhimbili National Hospital, Tanzania. BMC research notes. 2014;7(1):500.
30. Livingston JC, Llata E, Rinehart E, Leidwanger C, Mabie B, Haddad B, et al. Gentamicin and clindamycin therapy in postpartum endometritis: the efficacy of daily dosing versus dosing every 8 hours. American journal of obstetrics and gynecology. 2003;188(1):149-52.
31. DiZerega G, Yonekura L, Roy S, Nakamura R, Ledger W. A comparison of clindamycin-gentamicin and penicillin-gentamicin in the treatment of post-cesarean section endomyometritis. American journal of obstetrics and gynecology. 1979;134(3):238.
32. Mitra AG, Whitten MK, Laurent SL, Anderson WE. A randomized, prospective study comparing once-daily gentamicin versus thrice-daily gentamicin in the treatment of puerperal infection. American journal of obstetrics and gynecology. 1997;177(4):786-92.
33. Mawalla B, Mshana SE, Chalya PL, Imirzalioglu C, Mahalu W. Predictors of surgical site infections among patients undergoing major surgery at Bugando Medical Centre in Northwestern Tanzania. BMC surgery. 2011;11(1):21.
34. GALL SA, KOHAN AP, AYERS OM, HUGHES CE, Addison WA, HILL GB. Intravenous metronidazole or clindamycin with tobramycin for therapy of pelvic infections. Obstetrics & Gynecology. 1981;57(1):51-8.
35. French L, Smaill FM. Antibiotic regimens for endometritis after delivery. The Cochrane Library. 2004.
36. Bode LG, Kluytmans JA, Wertheim HF, Bogaers D, Vandenbroucke-Grauls CM, Roosendaal R, et al. Preventing surgical-site infections in nasal carriers of Staphylococcus aureus. New England Journal of Medicine. 2010;362(1):9-17.
37. Koneman EW, Allen SD, Janda WM, Schreckenberger PC, W.C W. Color Atlas and Textbook of Diagnostic Microbiology. : Lippincott.; 1997.
38. Healthy TMo. National treatment guideline. 2013.
39. NBS. Tanzania Demographic and Health Survey 2010. United Republic of Tanzania; 2011.
40. Israel GD. Determining sample size: University of Florida Cooperative Extension Service, Institute of Food and Agriculture Sciences, EDIS Gainesville; 1992.
41. Lehmann PF. PR Murray, EJ Baron, MA Pfaller, FC Tenover and RH Yolken, eds. Manual of Clinical Microbiology. Mycopathologia. 1999;146(2):107-8.
42. Lu P-L, Liu Y-C, Toh H-S, Lee Y-L, Liu Y-M, Ho C-M, et al. Epidemiology and antimicrobial susceptibility profiles of Gram-negative bacteria causing urinary tract infections in the Asia-Pacific region: 2009–2010 results from the Study for Monitoring Antimicrobial Resistance Trends (SMART). International journal of antimicrobial agents. 2012;40:S37-S43.
43. Taskin T, Sultana M, Islam T, Khan NA, Chowdhury SM. Socio-demographic Factors and Puerperal Sepsis: Experiences from Two Tertiary Level Hospitals in Bangladesh. International Journal of Community & Family Medicine. 2016;2016.

44. Organization WH. The prevention and management of puerperal infections: report of a technical working group, Geneva, 20-22 May 1992. 1995.
45. van Dillen J, Zwart J, Schutte J, van Roosmalen J. Maternal sepsis: epidemiology, etiology and outcome. Current opinion in infectious diseases. 2010;23(3):249-54.
46. Seni J, Najjuka CF, Kateete DP, Makobore P, Joloba ML, Kajumbula H, et al. Antimicrobial resistance in hospitalized surgical patients: a silently emerging public health concern in Uganda. BMC research notes. 2013;6(1):298.