Hovedoppgave

NTNU
Norges teknisk-naturvitenskapelige universitet
Fakultet for medisin og helsevitenskap
Institutt for samfunnsmedisin og sykepleie

Gunnar Wang-Haugseth og Martin Dedekam Sveen

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Hovedoppgave i Profesjonsstudiet medisin
Veileder: Jon Ø. Odland
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Januar 2022

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Sammendrag

Introduksjon

Av de ulike årsakene til maternell død er maternell infeksjon og sepsis (MIS) en viktig bidragsyter, spesielt i lav- og mellominntektsland. Globale mål om å redusere maternell mortalitetsrate har blitt foreslått av både Verdens helseorganisasjon og Forente Nasjoner, og å redusere byrden av MIS er derfor avgjørende for å nå disse målene. Denne studien søker å oppklare trender og utfall av MIS ved Queen Elizabeth Central Hospital, Blantyre, Malawi.

Metode

Vi utførte en retrospektiv tverrsnittsstudie av pasienter ved avdeling for obstetrikk og gynekologi ved Queen Elizabeth Central Hospital mellom 2016 og 2021. Alle pasientjournaler på avdelingen ble inkludert i studien. Vi estimerte prevalens, årsaker, og gjorde en multivariabel regresjonsanalyse for å finne variabler assosiert med MIS, og for å avgjøre risikoen for maternell død hos pasienter med MIS.

Resultater

Vi estimerte prevalens av MIS til å være syv prosent 95% CI [0.055, 0.096]. MIS sto for 35% 95% CI [15.4-59.2] av maternell død som resulterte i en odds ratio (OR) = 9.66 95% CI [1.94, 48.05] for MIS-gruppen når vi sammenlignet med ikke-MIS. Kvinner med HIV hadde nesten tre ganger (OR 2.79, 95% CI 1.37- 5.68) høyere sjanse for å få MIS sammenlignet med HIV negative.

Diskusjon

Funn av MIS-prevalens, at MIS-pasienter har en høyere risiko for maternell død, og at HIV-positive kvinner har en høyere risiko for å få MIS, er støttet av andre studier. Vi fant ingen signifikante resultater da vi undersøkte risiko for MIS mot svangerskapskomplikasjoner, føtalt utfall, og potensielle risikofaktorer slik som kirurgisk intervensjon eller keisersnitt.

Konklusjon

I Malawi er MIS sterkt assosiert med maternell død. For å redusere maternell mortalitet må det forskes videre på temaet, slik at en kan utarbeide retningslinjer for å redusere risikofaktorer, og derav prevalensen av MIS.

Abstract

Introduction

Maternal sepsis and infection (MIS) is an important contributor to maternal death, especially in low to medium income countries. Global goals to reduce maternal mortality rate have been proposed by both the World Health Organization and the United Nations, and reducing the burden of MIS is therefore crucial to help reach these goals. This study aims to clarify the trends and outcomes of MIS in Queen Elizabeth Central Hospital, Blantyre, Malawi.

Method

We performed a retrospective cross-sectional study of patient files at the department of obstetrics and gynaecology at Queen Elizabeth Central Hospital between 2016 and 2021. All patient files admitted to the department were included in our study. We estimated the prevalence, causes, and did a multivariable regression analysis to find variables associated with MIS, and to determine the risk for maternal death when acquired MIS.

Results

We estimated a prevalence of MIS to seven percent 95% CI [0.055, 0.096]. MIS accounted for 35% 95% CI [15.4-59.2] of maternal deaths resulting in an OR = 9.66 95% CI [1.94, 48.05] for the MIS group compared to non-MIS. Women with HIV have almost three times (OR 2.79, 95% CI 1.37- 5.68) higher chance of acquiring MIS compared to HIV negatives.

Discussion

Our findings of MIS prevalence, that MIS patients have a high risk of maternal death, and that HIV positive women have a higher risk of acquiring MIS, are supported by other studies. No significant results were found when looking at risk of MIS for pregnancy complications, fetal outcome or other potential risk factors such as surgical intervention or cesarean section.

Conclusion

In Malawi, MIS is strongly associated with maternal death. In order to reduce maternal mortality, further investigation needs to be done in order to develop guidelines for reducing risk factors, and so the prevalence of MIS.

Introduction

Maternal sepsis is a major cause of maternal death globally, with an estimated proportion of maternal sepsis related deaths of 11% between 2003 and 2009. (1) Maternal sepsis particularly affects low and middle-income countries (LMIC), with proportions of maternal deaths due to maternal infection and sepsis (MIS) being five times higher in Africa than developed countries. (9.7% versus 2.1% respectively). (2) Death due to MIS in sub-Saharan Africa is poorly described due to the inconsistent terms and definitions, in addition to lack of data on the subject. (3, 4) Thus, it is likely that the numbers might be even higher. (5)

MIS may be an even bigger problem in Malawi. Studies conducted in the region estimate higher proportions of maternal deaths due to maternal sepsis, ranging from 11% to 16.3%. (6, 7) Other studies estimates this proportion to be up to 24%, (6) yet this still might be an underestimation, owing to the lack of standard case definitions and diagnostic modalities.

The United Nations sustainable development goals aim to reduce the global maternal mortality ratio (MMR) to less than 70 per 100 000 live births by 2030. (8) In 2015, the global MMR was 216 per 100 000 live births, thus more reductions in MMR are needed. The MMR is 20 times higher in developing countries than in developed countries, thus it is expected that greater efforts are required in LMICs in order to achieve the United Nations sustainable development goals' target. (9)

Death from maternal sepsis is rare in high-income countries. (2) On a population level, poverty is the most important risk factor for maternal death from sepsis. (5) This may be due to a host of factors working together, including a lack of educated health staff, unhygienic conditions, low availability of antibiotics and inadequate monitoring of patients resulting in failure to recognize the severity of the infection. (5) As sepsis is one of the most preventable causes of maternal death, (5) interventions to address MIS, including surveillance systems, hospital resources mobilization, and education and awareness campaigns will enable a focussed approach to patients with MIS and reduce the amount of poor outcomes.

The World Health Organization issued a statement on maternal sepsis in which they outlined the goal to accelerate the reduction of preventable maternal and neonatal deaths related to sepsis. (10) To achieve this, it is important to understand the risk factors, trends, and

outcomes of maternal infections that develop into sepsis. Better overview of factors associated with poorer outcomes will make it easier to identify the severe cases early and administer the correct treatment. (4)

This study will illuminate the trends and outcomes of MIS from 2016 to 2021 at the Department of Obstetrics and Gynaecology (DOG) at the Queen Elizabeth Central Hospital (QECH) in Blantyre, Malawi. The main aims of this study were to describe the burden of MIS in the department, to describe the factors associated with MIS, and to describe the factors associated with poor outcomes of MIS.

Method

Study design and participants

We conducted a cross-sectional study using retrospectively collected facility-based patient files from 2016 to 2021 to determine trends and outcomes of MIS at QECH. The files were collected from the DOG in QECH. QECH is a tertiary health facility located in Blantyre, Malawi, which receives about 1200 admissions to the DOG each month.

Definitions

We defined maternal infection as any case file with a documentation of a suspected or confirmed infection from any microorganism or affecting any anatomical site. Maternal sepsis was defined by either documentation in the patient file, or maternal infection plus vital signs reflecting a qSOFA score of at least 2, as there were no routine culture services available to the department previously. (11) This is reflected in the new World Health Organization definition: *"a life- threatening condition defined as organ dysfunction resulting from infection during pregnancy, childbirth, post- abortion, or postpartum period*." (10)

Inclusion and exclusion criteria

We included all patient files across the late period of pregnancy (peripartum, intrapartum and up to 42 days post-termination of pregnancy) to reflect the new World Health Organization definition of maternal infections and sepsis. (10) We excluded incomplete case files and records of patients who were in the department for conditions not related to the pregnancy period.

Data source

Files were provided by employees from the department. Hand-written patient files were manually reviewed and the information extracted using the Open Data Kit software to digitize and organize the data. Age, date of admission and departure, earlier pregnancy status, known infectious diseases (e.g HIV, malaria, syphilis), vital signs, provisional diagnosis, mode of delivery and its complications, complications of the pregnancy, medications, and fetal and maternal outcome were registered using the form. Logic checks and validation codes were created to ensure data quality during data collection. The Open Data Kit form was created in accordance with the ICH-GCP guidelines to protect the safety, rights and welfare of the patients enrolled in this study. Following this, the data was anonymized during collection and uploaded to a secure server at the Kamuzu University of Health Sciences where it was managed. The final dataset was shared securely with the investigators in Norway for statistical analysis.

Ethical approval was obtained from both the College of Medicine Research Ethics Committee and the Regional Committee for Medical and Health Research Ethics Central (REK). (Number of REK-approval: 322956)

Statistical analyses

All statistical analyses were conducted in Microsoft Excel (Excel version 16.56) and using IBM SPSS Statistics version 27. Descriptive statistics (means and standard deviations (SD) or medians and interquartile ranges (IQR) where suitable) were used to summarize and produce a table of demographics of the characteristics of the participants. The prevalence of MIS was calculated and, using cross tabulation and Pearson chi square test, we stratified the prevalence of MIS by different variables to find associated factors and outcomes. For non-parametric scale variables, we used the Mann Whitney U test. We performed a binary logistical multivariable regression analysis to estimate odds of acquiring MIS and odds of maternal death in MIS patients for different factors and complications related to pregnancy. All analyses were done at the 5% significance level and reported along with 95% confidence intervals.

Results

Study population and table of demographics

From september 2021 to november 2021, 676 files in relation to pregnancies were reviewed. The patients as a group had a mean age of 25.1 years (SD = 6.6), and mean gravida and para status of 2.4 (SD = 1.5) and 1.3 (SD = 1.4) respectively. The women were mainly admitted to the gynaecology ward (90.2%, 610/676), followed by the labour ward (7.4%, 50/676) with a mean length of hospital stay of 4.7 days (SD = 7.6). Of the women who were admitted to another ward initially, 3.0% (20/676) were transferred to the ICU and 1.3% (9/676) to the labour ward HDU. Eighteen percent (117/648) of the tested women had a positive HIV-status and 81.9% (531/648) had a negative. Of the syphilis tests taken, 4.9% (27/550) were positive whereas 95.1% (523/550) were negative. Of the MRDT taken, only 6.5% (7/107) were positive and 93.5% (100/107) tested negative.

Overall, the patients had normal vital signs (mean reported findings of systolic and diastolic blood pressure, heart rate, respiratory rate, temperature and oxygen saturation were 124.5 mmHg (SD = 19.4 mmHg), 79.9 mmHg (SD = 15.0 mmHg), 92.4bpm (SD = 15.9 bpm), 18.9 bpm (SD = 3.7 bpm), 36.1 ^{o}C (SD = 0.8 ^{o}C) and 98.1% (SD = 2.0%) respectively). The majority of the women did not experience any complications with their pregnancy (82.0%, 554/676). The complication most often reported was preeclampsia (6.1%, 41/676) followed by gestational hypertension (5.0%, 34/676) and postpartum hemorrhage (3.3%, 22/676). Forty-two percent (283/676) gave birth vaginally compared to 58.1% (393/676) that ended in a cesarean section (CS). In total 3.0% (20/676) of the admitted women, and 3.9% (26/667) of the fetuses died. The mean APGAR after 10 minutes was 9.6 (SD = 1.2). The demographic, clinical and diagnostic information as well as information regarding hospitalization and outcomes are presented in Table 1.

Reason for admission

The most common reasons for admission were labour and previous scar (38.5%, 260/676 and 17.0%, 115/676 respectively). Other commonly reported conditions were obstructed labour (13.5%, 91/676), followed by preeclampsia/eclampsia and hypertension in pregnancy. (6.7%, 45/676 and 4.1%, 28/676) Figure 1a and b shows the distribution of reasons for admittance to DOG. All patients are represented with only one diagnosis.

Prevalence and characteristics of MIS cases

Fifty women were clinically diagnosed with an infection or sepsis when admitted to the hospital resulting in an estimation of prevalence of MIS in our study to be seven percent 95% CI [0.055, 0.096].

The most common diagnoses for MIS were syphilis, urinary tract infections and malaria infection (52%, 25/50, 18%, 9/50 and 14%, 7/50 respectively). Proportions of reported causes of MIS in our study population are displayed in Figure 2.

Factors associated with MIS

The proportion of HIV-positive cases was notably higher in the MIS group than in the non-MIS group (39.6%, 19/48 and 16.3%, 98/600, p-value <0.001). Beside this, complications related to pregnancy were in general more prevalent in the non-MIS group, except for PPROM/PROM and "other complications". Different factors associated with MIS compared to the non-MIS group are shown in Table 2.

Outcome proportions of MIS

Maternal death rate was higher in the MIS group (14.0%, 7/50) than the non-MIS (2.1%, 13/626) with a p-value <0.001. MIS accounted for 35% 95% CI [15.4, 59.2] of the total number of maternal deaths (n= 20) in our study. The fetal death rate was the same in both groups (4.2%, 2/47 and 3.9%, 24/620 respectively), p-value = 0.896. The proportion of patients undergoing surgical intervention was about the same in both groups (10.4%, 5/48 and 7.8%, 48/619) p-value = 0.511. Outcome proportions as maternal, fetal outcome and surgical intervention are compared between the MIS group and the non-MIS group in table 3.

Risk of maternal death

The odds ratio (OR) of maternal death when adjusted for HIV-status, age, parity, delivery mode, surgical interventions, length of hospital stay, and pregnancy complications was much higher (OR 9.66, 95% CI 1.94-48.05) in patients with MIS than those without. The adjusted OR for maternal death increases with increasing parity status (para 1 OR= 7.03, 95% CI 0.80 – 61.52, para 2 OR= 33.79, 95% CI 2.13 – 536.50, para 3 OR= 137.25, 95% CI 4.07 – 4630.70). We also found an increased OR of maternal death for women with postpartum hemorrhage (OR 33.25, 95% CI 1.12-1000.62), eclampsia (OR 35.78, 95% CI 1.41- 906.71) and PPROM/PROM (OR 5.11, 95% CI 0.11-235.27). This analysis is shown in table 4.

Risk of maternal infection and sepsis

Women with HIV have almost three times higher chance of acquiring MIS during late pregnancy, peripartum or postpartum period (OR 2.79, 95% CI 1.37-5.68) compared to HIV negatives. We also found that women who had a CS performed or had any other surgical intervention had about the same risk as vaginal delivery or no surgical intervention of acquiring MIS (CS OR 0.94, 95% CI 0.48-1.82, surgical intervention OR 1.00, 95% CI 0.26-3.81). Potential risk factors for MIS are shown in Table 5.

Discussion

Our study estimated a MIS prevalence of seven percent, with syphilis, urinary tract infections and malaria being the main contributors to MIS. We also found an increased prevalence of maternal mortality in the patients with MIS; cases of MIS were almost 10 times more likely to die than women without MIS. In addition, the risk of acquiring MIS was also higher if the patient was HIV positive. We did not observe any association between MIS, pregnancy complications, delivery via CS, or other potential risk factors such as other surgical interventions.

Our estimation of MIS prevalence was seven percent, and the Global Maternal Sepsis Study showed the same prevalence globally. (4) One would assume that the prevalence would be higher in Malawi than the global average, but MIS are often misdiagnosed or diagnosed too late in LMICs which leads to underreporting. (12) It is probable that this is also the situation for our study population, leading to a possible underestimation of MIS. Additionally, other studies' definitions of MIS could vary from our own and make the results difficult to compare (e.g. inclusion of syphilis and malaria as MIS in our study).

We found that 35% of the total number of mortality cases was due to MIS. This is higher than previous studies from the region. (6, 13) This is likely due to the expansive definition of MIS used in this study, compared to earlier studies. Interestingly, the proportion of mortality was found to be the same in both groups when considering fetal death. This is contrary to studies showing that perinatal mortality is elevated in cases with MIS. (14) The reason for these results could be lack of adequate data.

Our study found the prevalence of HIV to be 18%. This estimate is the same prevalence of HIV in the referral area of QECH compared to what other studies have found. (15, 16) Our multivariable regression analysis shows that the risk of acquiring MIS when HIV positive was significantly higher than the HIV negative population. HIV positive women are more susceptible for acquiring infectious complications in pregnancy, which strengthens the validity of our findings. (13) Better HIV-prevention, treatment and proper follow-ups for HIV infected women might therefore help to reduce the total burden of MIS, especially as the prevalence of HIV is reported to increase in Malawi. (17)

Syphilis and malaria were the biggest contributors to the MIS group. Our study estimates a prevalence of five percent, which is higher than previous estimates of the syphilis prevalence in Malawi. (14) The reason for this is most likely that our study concerns women needing hospital management. This gives a higher proportion of complicated pregnancies than what we are likely to find in the rest of the population. Syphilis is an important contributor to complicated pregnancies, and a positive syphilis or malaria test might have been the reason for the hospital admission itself, increasing our number of MIS cases. (18) However, the prevalence of malaria was estimated to be seven percent in our study whereas a study on prevalence of malaria from 2015 estimates a prevalence of 20%. (19) In some files, the test was not done when clinically needed, or the results of the test were not received and/or recorded. This probably caused an underestimation of the prevalence of malaria, consequently causing an underestimation of MIS in our study.

Nearly 60% of the women gave birth through CS, much higher than the nine percent Unicef estimated as the CS rate in urban areas of Malawi. (20) As QECH is the largest government tertiary hospital in Malawi, it receives referrals from other central hospitals and district hospitals in southern Malawi. This results in the hospital having the most educated staff and resources. Patients requiring CSs are therefore referred from a large non-urban area, accumulating the number of women needing the procedure, making the comparison to the UNICEF data difficult. The increasing prevalence of HIV might explain some of the reported difference, as HIV is a risk factor for having a CS performed at the clinic.

Our study found a high proportion of CSs, but failed to find a significant correlation with MIS, even though CSs are a known risk factor for acquiring MIS. (21) One possibility is that performed CSs are not necessarily followed up by QECH postpartum. Transportation to the

hospital is expensive for the average Malawian and possible surgical site infection following the CS might be handled by local health institutions. Since all patient files are physical, and there is a lack of information being shared between institutions, fewer postpartum infections and sepsis cases would then be registered in our study.

We found a significant increase in OR for maternal death with increasing parity status. We also found a significant decrease in OR for maternal death with increasing age. However, these results must be carefully interpreted. The mean para of 1.3 and mean gravida of 2.4 skewed our study population towards low para and gravida. This resulted in a large variability of the ORs. Teenage pregnancy and grand multiparity are common in LMICs and are both possible risk factors for maternal death which might explain our results. (22-24)

There are several limitations in our study. Due to the method of record retrieval, as well as the disorganized status of files, and the uncertainty about receiving all the patient files from the years investigated, there is a risk of selection bias. There was also a potential of data entry errors during the study due to incomprehensible handwriting in some files, possibly resulting in additional selection bias through error of transcription and error of omission of data. However, this does not negate our findings for the primary objective owing to the moderately large sample size. Our data was sampled from the largest tertiary hospital in Malawi, which is a referral centre handling mostly complicated cases, thus the results are not generalizable beyond such a setting. Finally, despite the overall large sample, the study was not powered to provide significant information with regards to different risk factors, thereby restricting the conclusions that can be drawn from the study. It does, however, provide insights into the paradigm of MIS at QECH, informing more robust studies that are to be conducted in the future.

This was a relatively large cross-sectional study on the prevalence of MIS in a tertiary hospital. The large sample size allows for a more precise estimate of the prevalence of MIS. Also, the fact that the study has taken place in Malawi's largest referral hospital strengthens the study in that there is the greatest variation with regards to patient demographics, geographical distribution, socio-economic status and presentation to the hospital. Several studies are conducted in Malawi regarding maternal death, but studies specifically looking at trends and outcomes of MIS in Malawi are lacking.

Conclusion

In conclusion, MIS remains a significant contributor towards maternal mortality in Blantyre, and is strongly related to the persistent burden of HIV/AIDS. Strategies to address the epidemic of HIV in the region would help to reduce the overall burden of MIS. Further investigation needs to be done on MIS and its associated risk factors in order to develop focused guidelines to address the disease in the region.

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Table 1. Demographic characteristics of study participants

Characteristic	Overall study population (n=676)
Age (mean(SD))	25.1 (6.6)
Gravida (mean(SD))	2.4 (1.5)
Para (mean(SD))	1.3 (1.4)
Ward (%)	
Labour ward	50 (7.4)
Gynae ward	610 (90.2)
Labour ward HDU	8 (1.2)
Post-Natal ward	3 (0.4)
Antenatal Ward	5 (0.7)
HIV status (%)[a]	
Positive	117 (18.1)
Negative	531 (81.9)
Syphilis status (%)[b]	
Positive	27 (4.9)
negative	523 (95.1)
Malaria (%)[c]	
Positive	7 (6.5)
Negative	100 (93.5)
Maternal outcome (%)	
Alive	656 (97.0)
Dead	20 (3.0)
Fetal outcome (%)[d]	
Alive	641 (96.1)
Dead	26 (3.9)
Length of hospital stay in days (mean(SD))[e]	4.7 (7.6)
APGAR 10min (mean(SD))[f]	9.6 (1.2)
Vital signs (mean(SD))	
Systolic BP (n = 670)	124.5 (19.4)
Diastolic BP (n = 670)	79.9 (15.0)
Heart rate (n = 667)	92.4 (15.9)
Respiratory rate (n = 382)	18.9 (3.7)
Temperature (n = 489)	36.1 (0.8)
Oxygen saturation (n = 175)	98.1 (2.0)
Labour ward HDU admissions (%)	9 (1.3)
Patients admitted to ICU (%)	20 (3.0)
Mode of delivery (%)	
C/S	393 (58.1)
Vaginal	283 (41.9)
Complications of pregnancy (%)	
None	554 (82.0)
Gestational hypertension	34 (5.0)
Preeclampsia	41 (6.1)
Eclampsia	11 (1.6)
Diabetes in pregnancy	3 (0.4)
APH	10 (1.5)
PPH	22 (3.3)
PPROM/PROM[g]	12 (1.8)
Other	16 (2.4)

[a] Removed 28 participants due to unknown status
[b]Removed 126 participants due to unknown status
[c]Removed 569 participants due to unknown status
[d]Removed 9 participants due to unknown status
[e]Removed 8 participants due to typing error (>365 hospital days)
[f]Removed 35 participants due to unknown status
[g]Premature prelabour rupture of membranes/prelabour rupture of membranes

Table 2. Factors associated with maternal infection and sepsis

	Infection and sepsis; n=50	Non infection and sepsis; n=626	P-values[a]
HIV status (%)[b]			p = <0.001
Positive	19 (39.6)	98 (16.3)	
Negative	29 (60.4)	502 (83.7)	
Length of hospital stay in days (mean(SD))[c]	6 (6.7)	4.6 (7.6)	p = 0.269
Delivery mode (%)			p = 0.361
C/S	26 (52.0)	367 (58.6)	
Vaginal delivery	24 (48.0)	259 (41.4)	
APGAR score (mean(SD))[d]	9.6 (0.8)	9.6 (1.2)	p = 0.678
Complications (%)			
None	42 (84.0)	512 (81.8)	p = 0.696
Gestational hypertension	0 (0)	34 (5.4)	p = 0.091
Preeclampsia	2 (4.0)	39 (6.2)	p = 0.525
Eclampsia	0 (0)	7 (1.1)	p = 0.345
Diabetes in pregnancy	0 (0)	2 (0.3)	p = 0.624
APH	0 (0)	6 (1.0)	p = 0.368
PPH	1 (2.0)	21 (3.4)	p = 0.603
PPROM/PROM[e]	2 (4.0)	10 (1.6)	p = 0.216
Other complications	3 (6.0)	13 (2.1)	p = 0.079

[a]P-values calculated by pearson chi-square test. For the scale variables (Length of hospital stay in days and APGAR) we used Mann Whittney U test because of non-parametric values
[b]Removed 28 participants due to unknown status
[c]Removed 8 participants due to typing error. Length of hospital stay in days >365 days.
[d]Removed 35 participants due to unknown status
[e]Premature prelabour rupture of membranes/prelabour rupture of membranes

Table 3. Outcome proportions of maternal infection and sepsis

	Infection and sepsis group; n=50	Non infection and sepsis; n=626	P-values[a]
Maternal outcome (%)			p = <0.001
Alive	43 (86.0)	613 (97.9)	
Dead	7 (14.0)	13 (2.1)	
Fetal outcome (%)[b]			p = 0.896
Alive	45 (96.0)	596 (96.1)	
Dead	2 (4.0)	24 (3.9)	
Surgical interventions (%)[c]			p = 0.511
None	43 (90.0)	571 (92.2)	
Surgical intervention[d]	5 (10.0)	48 (7.8)	

[a]P-values calculated by pearson chi-square test
[b]Removed 9 participants due to unknown status
[c]Removed 9 participants due to unknown status
[d]Hysterectomi, abdominal washout and other surgical intervention except cesarean section is included

Table 4. Risk of maternal death. Logistical multivariable regression analysis.

Variable	Levels	Odds ratio	Confidence interval (95%)	P-value
Maternal infection/sepsis	No	REF	REF	REF
	Yes	9.66	1.94, 48.05	0.006
HIV-status[a]	Negative	REF	REF	REF
	Positive	0.58	0.07, 4.61	0.604
Age		0.79	0.65, 0.96	0.018
Parity groups				
0	REF	REF	REF	0.048
1		7.03	0.80, 61.52	0.078
2		33.79	2.13, 536.50	0.013
>=3		137.25	4.07, 4630.70	0.006
Length of hospital stay (in days)[b]		1.02	0.99, 1.06	0.258
Delivery mode	Vaginal	REF	REF	REF
	Caesarean section	3.89	0.66, 22.95	0.134
Surgical intervention[c]	No	REF	REF	REF
	Yes	0.37	0.04, 3.95	0.411
Pregnancy complications				
None	No	REF	REF	REF
	Yes	0.45	0.02, 10.05	0.615
Gestational hypertension	No	REF	REF	REF
	Yes	0.000	0.000	0.998
Preeclampsia	No	REF	REF	REF
	Yes	7.20	0.46, 113.87	0.161
Eclampsia	No	REF	REF	REF
	Yes	35.78	1.41, 906.71	0.030
Gestational diabetes	No	REF	REF	REF
	Yes	0.000	0.000	0.999
Antepartum hemorrhage	No	REF	REF	REF
	Yes	0.000	0.000	0.999
Postpartum hemorrhage	No	REF	REF	REF
	Yes	33.25	1.12, 1000.62	0.044
PPROM/PROM[d]	No	REF	REF	REF
	Yes	5.11	0.11, 235.27	0.404
Other	No	REF	REF	REF
	Yes	8.50	0.42, 170.79	0.162

[a]Removed 28 participants due to unknown status
[b]Removed 8 participants due to typing error. Length of hospital stay in days>365 days
[c]Removed 11 participants due to unknown status
[d]Premature prelabour rupture of membranes/prelabour rupture of membranes

Table5. Risk of maternal infection and sepsis. Logistical multivariable regression analysis

Variable	Levels	Odds ratio	Confidence interval (95%)	P-value
HIV-status[a]	Negative	REF	REF	REF
	Positive	2.790	1.370, 5.682	0.005
Age		0.965	0.891, 1.045	0.376
Parity groups				
0	REF	REF	REF	
1		1.514	0.586, 3.910	0.392
2		1.987	0.623, 6.332	0.246
>=3		2.000	0.493, 8.112	0.332
Length of hospital stay (in days)[b]		1.012	0.985, 1.039	0.391
Delivery mode	Vaginal	REF	REF	REF
	Caesarean section	0.935	0.481, 1.817	0.842
Surgical intervention[c]	No	REF	REF	REF
	Yes	0.998	0.261, 3.814	0.998
Pregnancy complications				
None	No	REF	REF	REF
	Yes	0.000	0.000	0.998
Gestational hypertension	No	REF	REF	REF
	Yes	0.000	0.000	0.997
Preeclampsia	No	REF	REF	REF
	Yes	0.000	0.000	0.998
Eclampsia	No	REF	REF	REF
	Yes	0.000	0.000	0.998
Gestational diabetes	No	REF	REF	REF
	Yes	0.000	0.000	0.999
Antepartum hemorrhage	No	REF	REF	REF
	Yes	0.000	0.000	0.998
Postpartum hemorrhage	No	REF	REF	REF
	Yes	0.000	0.000	0.998
PPROM/PROM[d]	No	REF	REF	REF
	Yes	0.000	0.000	0.998
Other	No	REF	REF	REF
	Yes	0.000	0.000	0.998

[a]Removed 28 participants due to unknown status
[b]Removed 8 participants due to typing error. Length of hospital stay in days>365 days
[c]Removed 11 participants due to unknown status
[d]Premature prelabour rupture of membranes/prelabour rupture of membranes

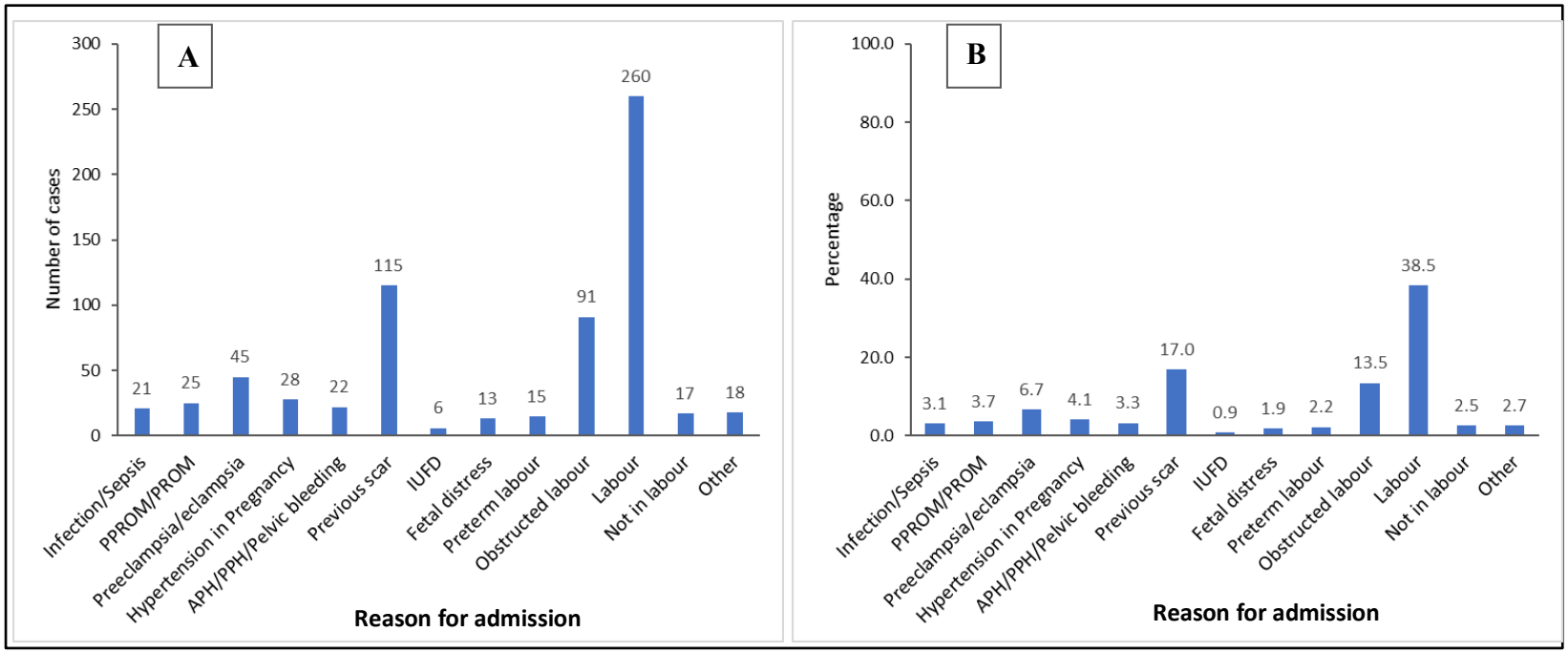


Figure 1. Graph displaying the distribution of reasons for admission to the DOG.

A: absolute number of cases for each reason for admission; B: percent distribution of reasons for admission

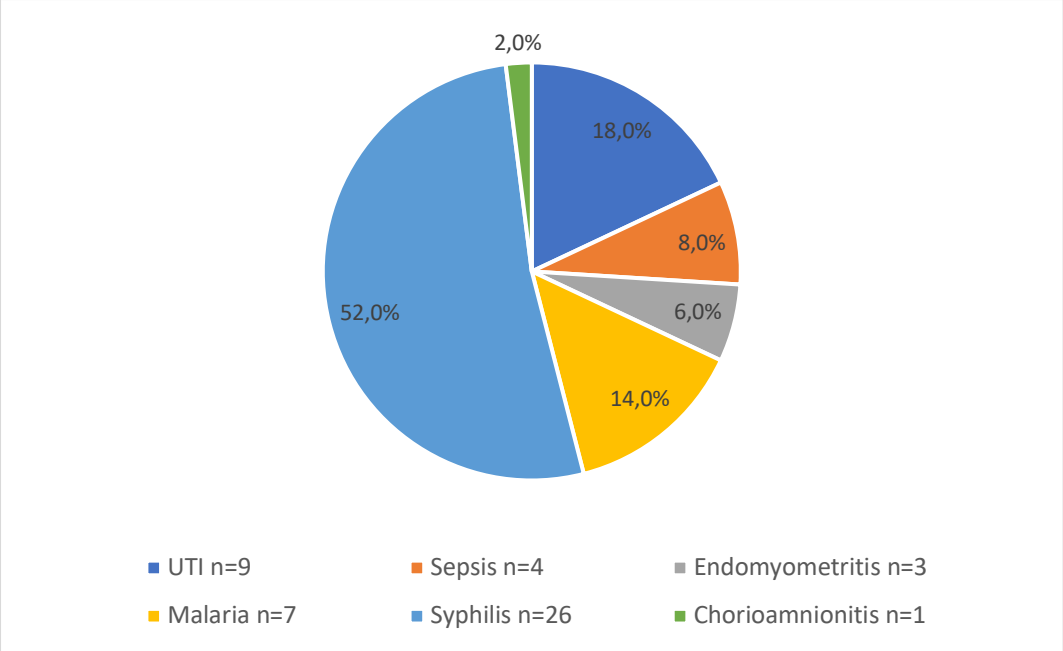
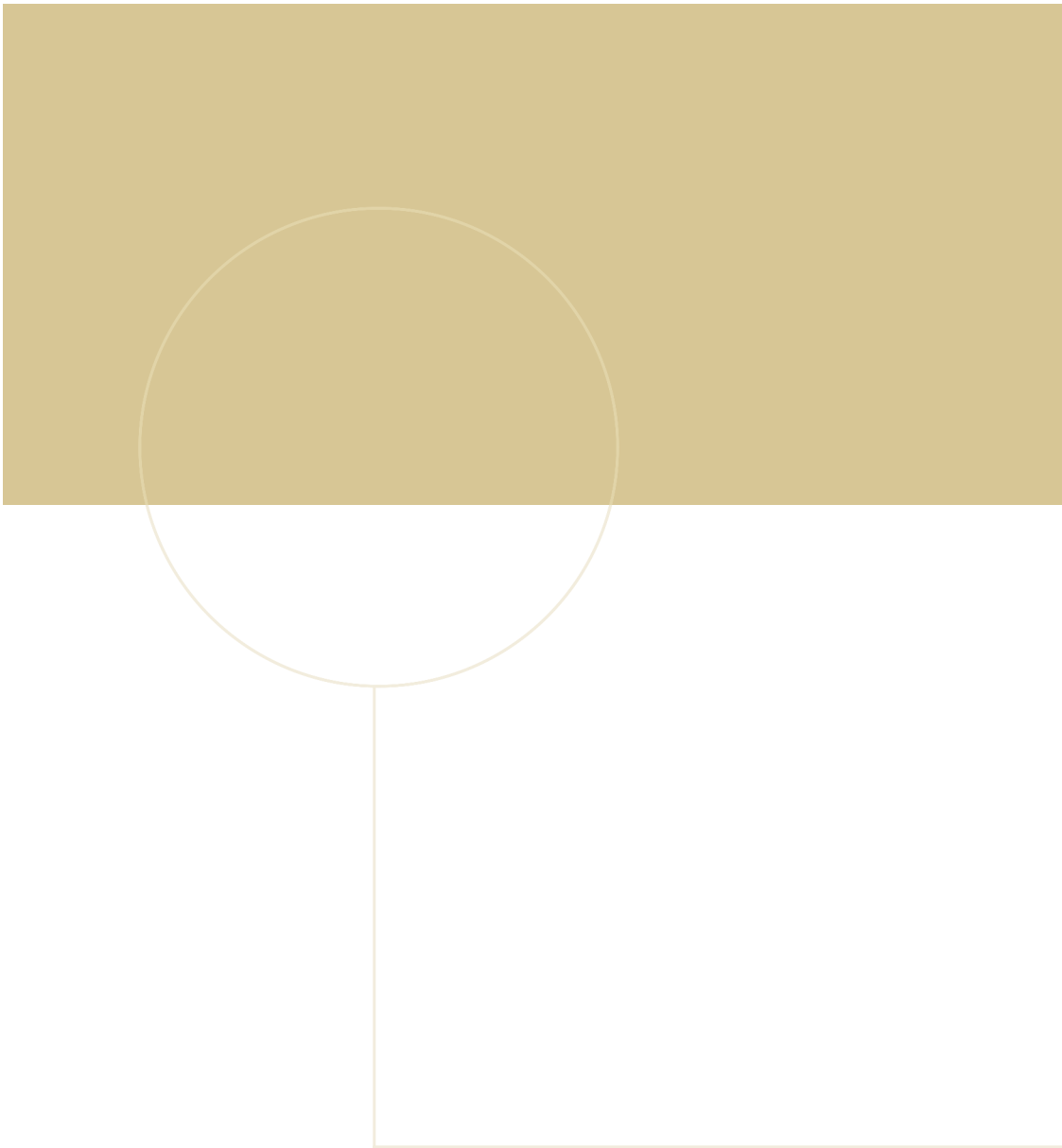


Figure 2. Distribution of causes of maternal infection and sepsis (n=50).



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