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Prevalence and Associated Factors of Neonatal Hospital Acquired Infection in Kabaya District Hospital, Rwanda

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Abstract: **Background: Neonatal hospital-acquired infections (HAIs) kill tens of thousands of children in sub-Saharan Africa annually, yet district-level burden data from Rwanda remain unpublished. This study determined the period prevalence and independent predictors of neonatal HAI at Kabaya District Hospital, Ngororero District, Western Province, Rwanda.**

Methods: Retrospective cross-sectional study of systematically sampled neonatal admission records (January 2022–December 2024). Of 1,704 admissions, every 4th record was selected (n=380); nine were excluded (analytic n=371). Primary outcome: clinician-ascertained HAI per CDC/NHSN criteria. Bivariate and multivariable logistic regression analysis at p<.05. Prevalence estimated with Wilson score 95% confidence intervals.

Results: Period prevalence was 13.7% (52/380; 95% CI [10.5%, 17.4%]). Sepsis predominated (55.8% of HAI cases). Case-fatality was 11.3%. Three independent predictors: maternal UTI history (aOR = 23.81, 95% CI [5.49, 103.31], p < .001), prolonged labour (aOR = 7.69, 95% CI [1.52, 38.92], p = .013), and perinatal asphyxia (aOR = 6.84, 95% CI [1.97, 23.72], p = .002). Hosmer–Lemeshow test confirmed model fit (χ^2 = 6.84, p = .554).

Cionclusion: Intrapartum complications account for the bulk of this facility's neonatal HAI burden. Antenatal UTI screening, intrapartum care improvement at health centres, and post-asphyxia infection prevention protocols are the highest-yield actionable targets.

Funding: None. Ethical clearance: Mount Kigali University IRB and Kabaya District Hospital administration.

Keywords: **neonatal sepsis; hospital-acquired infection; Rwanda; district hospital; perinatal asphyxia; maternal UTI; infection prevention; sub-Saharan Africa.**

1. INTRODUCTION

In 2021, internal records at Kabaya District Hospital documented a neonatal infection rate of 26.8% (Kabaya District Hospital, unpublished HMIS data, 2021). That figure went unanalysed for three years. This paper provides the epidemiological accounting it deserved.

Globally, neonatal sepsis kills between 400,000 and 700,000 children annually [1], with sub-Saharan Africa bearing 43% of all neonatal deaths worldwide. Beyond mortality, neonatal infections impose an enormous economic toll preterm birth complications and associated infections cost SSA health systems hundreds of millions of dollars annually in productivity losses[2].

The study identified a pooled neonatal sepsis rate of 2,824 per 100,000 live births in a systematic review of 26 studies, with a case-fatality rate of 17.6%[3]. Across East Africa, pooled prevalences average 29.7%[4].

Rwanda's national neonatal mortality rate fell from 44 to 17.8 per 1,000 live births between 2000 and 2022, yet the SDG target of 12 per 1,000 remains unmet[5,6]. Published Rwandan facility data confirm HAI burdens at all system levels: 59.3% at the University Teaching Hospital of Butare[7]; infection-related admission burden of 19.9% at Masaka District Hospital[8]; and 23.6% at Rwinkwavu and Kirehe hospitals[9].

Kabaya District Hospital, a 144-bed facility in Ngororero District, serves approximately 300,000 people across two districts. No peer-reviewed study has characterised the HAI burden or its determinants at this facility. This study fills that gap using three years of admission data.

2. METHODS

Study Design and Setting

This was a retrospective cross-sectional study at Kabaya District Hospital, Kabaya Sector, Ngororero District, Western Province, Rwanda, covering January 2022 to December 2024. The 144-bed facility serves a combined catchment of approximately 300,000 persons from Ngororero and Nyabihu Districts.

Sampling

Of 1,704 neonatal admissions across the study period, every 4th record was systematically selected (sampling interval $k \approx 4$), yielding $n = 380$. Sample size was calculated using the Cochran formula ($Z = 1.96$; $p = 0.374$ from the regional East African literature[4]; $\varepsilon = 0.05$). Nine records were excluded for missing infection-ascertainment data; final analytic $n = 371$.

Outcome Measurement

The primary outcome was clinician-ascertained neonatal HAI: infection arising after 48 hours of admission confirmed by clinical criteria and/or laboratory investigation, per WHO and CDC/NHSN neonatal surveillance definitions[10]. Infection type was classified as sepsis, pneumonia, meningitis, conjunctivitis, skin and soft tissue infection, syphilis, NEC, or other.

Data Collection

Two trained nurses extracted data using a structured checklist developed from published literature and the Rwanda Ministry of Health neonatal care protocol[11], piloted on 20 records from 2021. Inter-rater agreement on a 10% random subsample: percentage agreement 94.2%, Cohen's $\kappa = 0.89$.

Statistical Analysis

Prevalence estimated with 95% Wilson score CI. Pearson chi-square assessed bivariate associations; Fisher's Exact Test where expected cell counts fell below five. Multivariable binary logistic regression (Enter method) estimated aORs with 95% CIs. Model fit assessed by Hosmer–Lemeshow test and Nagelkerke R^2. Significance: two-tailed $p < .05$. Analyses performed in IBM SPSS v30.

Ethics

Ethical clearance: Mount Kigali University IRB and Kabaya District Hospital administration. Individual consent waived (retrospective study). Records de-identified per Rwanda's Data Protection Law No. 058/2021[12].

3. RESULTS

Sample Characteristics

Table 1 details the 380 enrolled neonates. Males predominated (53.2%); 30.8% were premature; 37.6% had low birth weight (<2.5 kg); 24.5% had perinatal asphyxia. Most mothers were aged 21–34 years (66.8%) and held community health insurance (96.6%). Invasive procedures were documented in 96.6% of neonates.

Table 1. Characteristics of enrolled neonates and their mothers, Kabaya District Hospital, Rwanda, 2022–2024 (N = 380).

Characteristic	Category	n	(%)
HAI confirmed	Yes	52	13.7
	No	319	83.9
Infection type†	Sepsis	29	55.8
	Pneumonia	3	5.8
	Skin/soft tissue	3	5.8
	Meningitis	1	1.9

	Conjunctivitis	1	1.9
	Syphilis	1	1.9
	NEC	1	1.9
	Other	13	25.0
Neonatal outcome	Cured	328	86.3
	Died	43	11.3
Sex	Male	202	53.2
	Female	169	44.5
Prematurity	Yes	117	30.8
	No	254	66.8
Birth weight	<2.5 kg	143	37.6
	≥2.5 kg	228	60.0
Perinatal asphyxia	Yes	93	24.5
	No	278	73.2
APGAR 1 min	8–10	160	42.1
	5–7	58	15.3
	<5	32	8.4
	Not recorded	121	31.8
APGAR 5 min	8–10	189	49.7
	5–7	48	12.6
	<5	10	2.6
	Not recorded	124	32.6
Maternal age (yr)	<20	37	9.7
	21–34	254	66.8
	35–49	79	20.8
Parity	1	158	41.6
	2–5	163	42.9
	>5	50	13.2
ANC visits	None	14	3.7
	1	47	12.4
	2	117	30.8
	3	111	29.2
	4+	82	21.6
Mode of delivery	Vaginal	273	71.8
	Caesarean	98	25.8
Place of delivery	Home/outside	69	18.2
	Health centre	98	25.8
	Hospital	204	53.7

Maternal UTI history	Yes	17	4.5
	No	354	93.2
Prolonged labour	Yes	8	2.1
	No	363	95.5
Length of stay	1–3 days	188	49.5
	4–7 days	110	28.9
	>7 days	69	18.2
Kangaroo Mother Care	Yes	71	18.7
	No	300	78.9
Invasive procedures	Yes	367	96.6
	No	4	1.1

Note. HAI = hospital-acquired infection; NEC = necrotising enterocolitis. †Infection type percentages among HAI cases (n = 52). Outcome percentages among all enrolled neonates. Values may not sum to 100% owing to missing data.

Prevalence and Infection Profile

52 neonates received a confirmed HAI diagnosis: period prevalence 13.7% (95% CI [10.5%, 17.4%]). All 52 had clinical onset within 72 hours of admission (early-onset). Sepsis was the dominant syndrome (55.8% of HAI cases; 7.6% of all enrolled neonates). Case-fatality was 11.3% (43/380).

Bivariate Analysis

Results appear in Table 2, ordered by p-value. Maternal UTI history produced the strongest association ($\chi^2 = 47.31$, $p < .001$): HAI occurred in 12 of 17 UTI-positive mothers' neonates (70.6%) vs. 40 of 354 without UTI (11.3%). Prolonged labour ($p = .003$), gestational age ($p = .004$), prematurity ($p = .007$), birth weight ($p = .013$), perinatal asphyxia ($p = .015$), and APGAR scores at 1 and 5 minutes ($p = .018, .038$) were each significant. Place of delivery was the sole significant facility-level predictor ($p = .005$); health centre births had the highest infection rate (23.5%). No socio-demographic variable was significant.

Table 2. – Bivariate analysis of factors associated with neonatal HAI, Kabaya District Hospital, Rwanda, 2022–2024 (N = 380).

Variable	Category	HAI n (%)	χ^2	p
Maternal UTI	Yes	12 (70.6)	47.31	<.001*
	No	40 (11.3)		
Prolonged labour	Yes	4 (50.0)	8.79	.003*
	No	48 (13.2)		
Gestational age	Premature	7 (6.2)	8.25	.004*
	Term	45 (17.4)		
Prematurity	Yes	8 (6.8)	7.31	.007*
	No	44 (17.3)		
Birth weight	<2.5 kg	12 (8.4)	6.11	.013*
	≥2.5 kg	40 (17.5)		
Perinatal asphyxia	Yes	6 (6.5)	5.89	.015*
	No	46 (16.6)		
APGAR 1 min	8–10	19 (11.9)	10.01	.018*
	5–7	6 (10.3)		

	<5	1 (3.1)		
APGAR 5 min	8–10	21 (11.1)	8.44	.038*
	5–7	5 (10.4)		
Place of delivery	Home	5 (7.3)	10.75	.005*
	Health centre	23 (23.5)		
	Hospital	24 (11.8)		
Mode of delivery	Vaginal	44 (16.1)	3.79	.052
Neonatal sex	Female	28 (16.6)	1.68	.195
	Male	24 (11.9)		
Parity	≥1 (grouped)	see text	5.79	.055
ANC visits	None–4+	—	5.53	.237
PROM	Yes	2 (28.6)	FET	.263
	No	50 (13.7)		
Multiple pregnancy	Yes	1 (33.3)	FET	.333
Health insurance	Yes	52 (14.2)	0.66	.417
Maternal age	<20	3 (8.1)	1.42	.700
	21–34	38 (15.0)		
Length of stay	1–3 d	22 (11.7)	3.54	.170
	4–7 d	21 (19.1)		
	>7 d	8 (11.6)		
KMC	Yes	6 (8.5)	2.26	.133
	No	46 (15.3)		
Invasive proc.‡	Yes	50 (13.6)	FET	.096
	No	2 (50.0)		

*Note. FET = Fisher's Exact Test (applied when expected cell count < 5). *p < .05. ‡Chi-square invalid (minimum expected count = 0.56); FET applied. Variables ordered by p-value.*

Multivariable Analysis

Three predictors were independently significant (Table 3). Maternal UTI history: aOR = 23.81, 95% CI [5.49, 103.31], p < .001. Prolonged labour: aOR = 7.69, 95% CI [1.52, 38.92], p = .013. Perinatal asphyxia: aOR = 6.84, 95% CI [1.97, 23.72], p = .002. The crude asphyxia estimate (cOR = 0.35) reversed on multivariable adjustment a Simpson's Paradox attributable to confounding by gestational age and birth weight; the adjusted estimate is the primary measure. Model fit: Hosmer–Lemeshow $\chi^2(8) = 6.84$, p = .554; Nagelkerke $R^2 = .31$.

Table 3. – Crude and adjusted predictors of neonatal HAI, multivariable logistic regression, Kabaya District Hospital, Rwanda, 2022–2024 (N = 371).

Predictor	Ref	cOR (95% CI)	p	aOR (95% CI)	p
Maternal UTI	No	18.87 (6.33–55.56)	<.001	23.81 (5.49–103.31)	<.001
Prolonged labour	No	6.58 (1.59–27.03)	.009	7.69 (1.52–38.92)	.013
Perinatal asphyxia§	No	0.35 (0.14–0.84)	.019	6.84 (1.97–23.72)	.002

Note. cOR = crude odds ratio; aOR = adjusted odds ratio. §Crude estimate reversed owing to confounding by gestational age and birth weight (Simpson's Paradox). Model: Hosmer–Lemeshow $\chi^2(8) = 6.84$, p = .554; Nagelkerke $R^2 = .31$.

4. DISCUSSION

Principal Findings

One in seven neonates admitted to Kabaya District Hospital acquired an infection. The 11.3% case-fatality proportion means roughly 11 deaths per 100 infected neonates not a statistical artefact but a preventable toll. Three modifiable intrapartum factors drove the risk: maternal UTI, prolonged labour, and perinatal asphyxia. Each maps directly to an intervention within the existing district health system architecture.

Prevalence in Context

At 13.7%, the Kabaya rate sits below infection-related admission burdens documented at Masaka District Hospital[8] and below the 23.6% at Rwinkwavu and Kirehe[9]. The 59.3% at the University Teaching Hospital of Butare[7] reflects tertiary patient-selection bias rather than a directly comparable HAI burden. Ethiopian NICU-level studies document rates of 34%[13] and meta-analytic pooled estimates of 36%[14]. A public-sector NICU study from KwaZulu-Natal documented analogous intrapartum risk profiles to our setting[15]. The 11.3% case-fatality proportion is consistent with global estimates of 11–17%[3,13].

Determinants

The UTI finding (aOR = 23.81) is biologically coherent: urinary uropathogens colonise the birth canal, cause chorioamnionitis, and transmit vertically to the neonate at delivery[16]. The prolonged labour association (aOR = 7.69) reflects ascending bacterial colonisation during extended membrane exposure and repeated intrapartum vaginal examinations[4,17], confirmed by an Ethiopian multicentre HAI case-control study[18]. The adjusted asphyxia effect (aOR = 6.84) reflects immune compromise plus resuscitation-related procedural exposure[19,20]. The absence of microbiological confirmation precludes organism-level profiling[21].

Limitations and Strengths

Single-facility retrospective design limits generalizability. Absent blood culture data for all cases precludes microbiological profiling. Unmeasured confounders (household wealth, maternal education) were not captured. The 52 HAI events produce wide confidence intervals. Invasive procedures (96.6% exposed) could not be meaningfully analysed as a predictor. Study not prospectively registered. Against these limitations: systematic sampling, high inter-rater reliability ($\kappa = .89$), transparent Simpson's Paradox reporting, correct Fisher's Exact Test application, and adequate Hosmer–Lemeshow fit.

Conclusion

Maternal UTI, prolonged labor, and perinatal asphyxia independently and substantially predict early-onset neonatal HAI at a rural Rwandan district hospital. Antenatal UTI screening is the highest-yield single intervention. Intrapartum care quality improvement at health centres and post-asphyxia infection prevention protocols complete the evidence-based package. Multicentric prospective studies with microbiological confirmation are the priority next step.

CONTRIBUTORS

J. D. Nyirimpuhwe: conception, design, data collection, analysis, drafting, final approval. A. Habimana: supervision, design, critical revision, approval. A. A. Kidane: statistical oversight, validation, critical revision, approval.

DECLARATION OF INTERESTS

The authors declare no competing interests.

DATA AVAILABILITY

De-identified analytic dataset available from corresponding author on request, subject to IRB and hospital administration approval per Rwanda Law governing data.

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