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Resources to support infection prevention and control in African neonatal units

Abstract: *Background:* Sub-Saharan African experiences the highest burden of neonatal sepsis and antimicrobial resistance attributable deaths globally due to inadequate infrastructure, resources, and staffing for infection prevention and control (IPC), sub-optimal cleaning, equipment sharing, and re-use of single-use items. *Methods:* Fourteen hospitals in the African Neonatal Network responded to an annual facility survey and a health facility survey co-developed by faculty in the African Neonatal Network and Vermont Oxford Network. All analyses use descriptive statistics. *Results:* Most hospitals (86%) had guidelines for IPC and policies for environmental cleaning (79%). Running water was routinely available at 9 hospitals (64%). Alcohol hand rub was regularly available at the patient bedside in 8 neonatal units (57%). Almost all neonatal units (93%) re-used single-use consumables and reported using non-standardised decontamination methods such as soaking in sodium hypochlorite. Oral and intravenous antibiotics

were shared between neonates at four hospitals (29%), while parenteral fluids were shared at six neonatal units (43%), with several units reporting prolonged use after opening and/or reconstituting medication and fluids.

Conclusion: Although most units had IPC and hospital cleaning guidelines, many lacked adequate infrastructure and consumables to support optimal IPC practices. Clinical care practices such as reprocessing of single-use items and sharing of parenteral fluids and medications, further highlight the major contribution of resource limitations to the burden of health-care associated infections in African neonatal units.

Keywords: Infant, Newborn; Infant, Premature; Sepsis / prevention & control; Infection Control / organization & administration; Cross Infection / prevention & control; Infection Control / standards; Health Facility Environment; Africa South of the Sahara; Global Health

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Résumé: *Contexte:* L'Afrique subsaharienne enregistre la charge la plus élevée au monde de sepsis néonatal et de décès attribuables à la résistance aux antimicrobiens, en raison d'infrastructures inadéquates, de ressources limitées et d'un personnel insuffisant pour la prévention et le contrôle des infections (PCI), d'un nettoyage sous-optimal, du partage de matériel et de la réutilisation d'articles à usage unique.

Méthodes: Quatorze hôpitaux du Réseau Néonatal Africain ont répondu à une enquête annuelle sur les structures de soins et à une enquête sur les établissements de santé, co-développées par des experts du Réseau Néonatal Africain et du Vermont Oxford Network. Toutes les analyses ont été réalisées à l'aide de statistiques descriptives.

Résultats: La majorité des hôpitaux (86 %) disposaient de directives pour la PCI, et 79 % avaient des politiques de nettoyage environnemental. De l'eau courante était disponible de manière régulière dans 9 hôpitaux (64 %), et une solution hydroalcoolique pour l'hygiène des mains était accessible au chevet du patient

dans 8 unités néonatales (57 %). Presque toutes les unités néonatales (93 %) réutilisaient des consommables à usage unique et signalaient l'utilisation de méthodes de décontamination non standardisées, telles que le trempage dans une solution d'hypochlorite de sodium. Des antibiotiques oraux et intraveineux étaient partagés entre les nouveau-nés dans quatre hôpitaux (29 %), et des solutés parentéraux dans six unités (43 %), plusieurs établissements rapportant une utilisation prolongée après ouverture et/ou reconstitution des médicaments et solutés.

Conclusion: Bien que la plupart des unités disposent de directives pour la PCI et le nettoyage hospitalier, beaucoup manquent d'infrastructures et de consommables adéquats pour mettre en œuvre des pratiques optimales. Les pratiques cliniques telles que la réutilisation d'articles à usage unique et le partage de solutés et de médicaments parentéraux illustrent davantage l'impact majeur des contraintes de ressources sur la charge infections associées aux soins dans les unités néonatales africaines.

Introduction

Neonatal sepsis causes up to 30% of neonatal deaths worldwide and is the third leading cause of mortality after preterm birth and intrapartum events.¹ The rate of neonatal sepsis in low- and middle-income countries (LMICs) is 20 times higher than that observed in high-income country neonatal units, with the sub-Saharan African region having both the highest neonatal mortality rates and antimicrobial resistance (AMR) attributable death rates globally.²

A systematic review of neonatal sepsis studies reported a prevalence of 29% in East African hospital neonatal units,³ with even higher neonatal sepsis prevalence rates of 50% documented in Ethiopian hospitals.⁴ Neonatal sepsis-related mortality rates in sub-Saharan Africa range from 17 to 29%, with healthcare-associated infection (HAI) being the largest contributor to infection-related neonatal deaths, as well as incurring long-term neuro developmental morbidity, prolonged hospitalization and increased health care costs.⁵

Gram negative bacteria are the predominant neonatal sepsis pathogens in African neonatal units, including *Klebsiella pneumoniae*, *Escherichia coli* and *Acinetobacter baumannii*, with *Staphylococcus aureus* and fungal infections also contributing substantially in some units.⁶ Factors associated with increased risk of neonatal HAI include low birth weight, prematurity, skin damage, absence of breastmilk feeding, neonatal unit overcrowding, sharing of equipment and lack of infection prevention and control (IPC) best practices.⁷ Inadequate expertise, resources and staffing for IPC, sub-optimal cleaning, lack of essential consumables and supplies leading to re-use of single-use items, reprocessing of shared equipment, and overuse of antibiotics are other important factors contributing to neonatal sepsis in Africa.⁷

Low cost bundled or multimodal IPC interventions have been successfully implemented in resource-limited settings to improve the quality and safety of care for hospitalised neonates, although few studies have been conducted in African neonatal units.⁸ Given the paucity of data on the continent, we evaluated surveys of IPC resources and practices at neonatal units in five African countries.

Methods

Data collection was conducted in 14 ANN member hospitals across five countries: Ethiopia, Nigeria, Rwanda, Uganda, and Zimbabwe.

Vermont Oxford Network (VON) conducts an annual survey for members that was co-developed with ANN faculty members, which includes information on the hospital setting, number of beds and admissions, staffing, obstetric service, follow-up clinic, resuscitation and essential newborn care, transfers and transport, family-centred care, services provided by the neonatal unit, guidelines in the neonatal unit, quality assurance/continuous quality improvement, and level of neonatal care. Participation in the membership survey is mandatory. The responses used for this manuscript are from 2023.

In October 2023, the ANN conducted a health facility assessment to collect more detailed information on buildings and facilities, medications, diagnostics and consumables, equipment, staffing, governance, thermal regulation and foetal transition, nutrition, family-centred care and kangaroo mother care, infection prevention and control, and perceived priorities.

Tables of hospital-level measures include data from both the membership survey and the health facility assessment. All analyses are descriptive.

The collaborative QI project and subsequent assessments received individual and hospital institutional research and ethics review approvals at the start of the collaborative and learning initiative.

Results

IPC guidelines, policies and practices

Most hospitals had existing IPC guidelines (12, 86%) and policies for environmental cleaning (11, 79%). Most neonatal units (13, 93%) had facilities for the safe disposal of hospital waste and sharps. Most neonatal units (12, 86%) used washing machines for washing infant linen, while two facilities (14%) reported washing infant linen by hand. Over half of respondents reported observing vermin (mice, cockroaches) and/or animal faeces in or near the neonatal unit (8, 57%).

Diagnostic microbiology services and neonatal infection surveillance

Most hospitals had onsite microbiology laboratories (13, 93%) and most neonatal units had an established system of monitoring neonatal sepsis cases over time (12, 86%). Almost two-thirds reported conducting AMR surveillance at the facility (9, 64%). Two-thirds of neonatal units had local protocols for the identification and management of bloodstream infections and meningitis (9, 64%). Two-thirds of neonatal units had local protocols for the identification and management of bloodstream

infections and meningitis.

Hand hygiene and personal protective equipment

Hand wash basins were available at most neonatal units (13, 93%), while running water was routinely available at nine hospitals (64%), with the rest having intermittent water supply (Table 1). Just over half of the neonatal units had alcohol hand rub regularly available at the patient bedside (8, 57%). Personal protective equipment (PPE) availability varied, with gloves, surgical masks and gowns being the most readily available PPE items in the neonatal unit (Table 1).

Equipment re-use and re-processing practices

Neonatal consumables such as nasal cannulae and respiratory circuits for non-invasive and invasive ventilation meant for single use were re-used by 13 (93%) of the neonatal units surveyed. Some units reported attempts to decontaminate respiratory tubing using sodium hypochlorite soaking and other unspecified methods (Fig 1). Sterilization of equipment was possible at thirteen (93%) of the surveyed facilities, with only one hospital (7%) reporting autoclaving CPAP nasal interfaces and circuits and the remainder utilizing bleach or other methods for sterilization when re-using and re-processing these supplies.

Management of intravenous fluids and medications

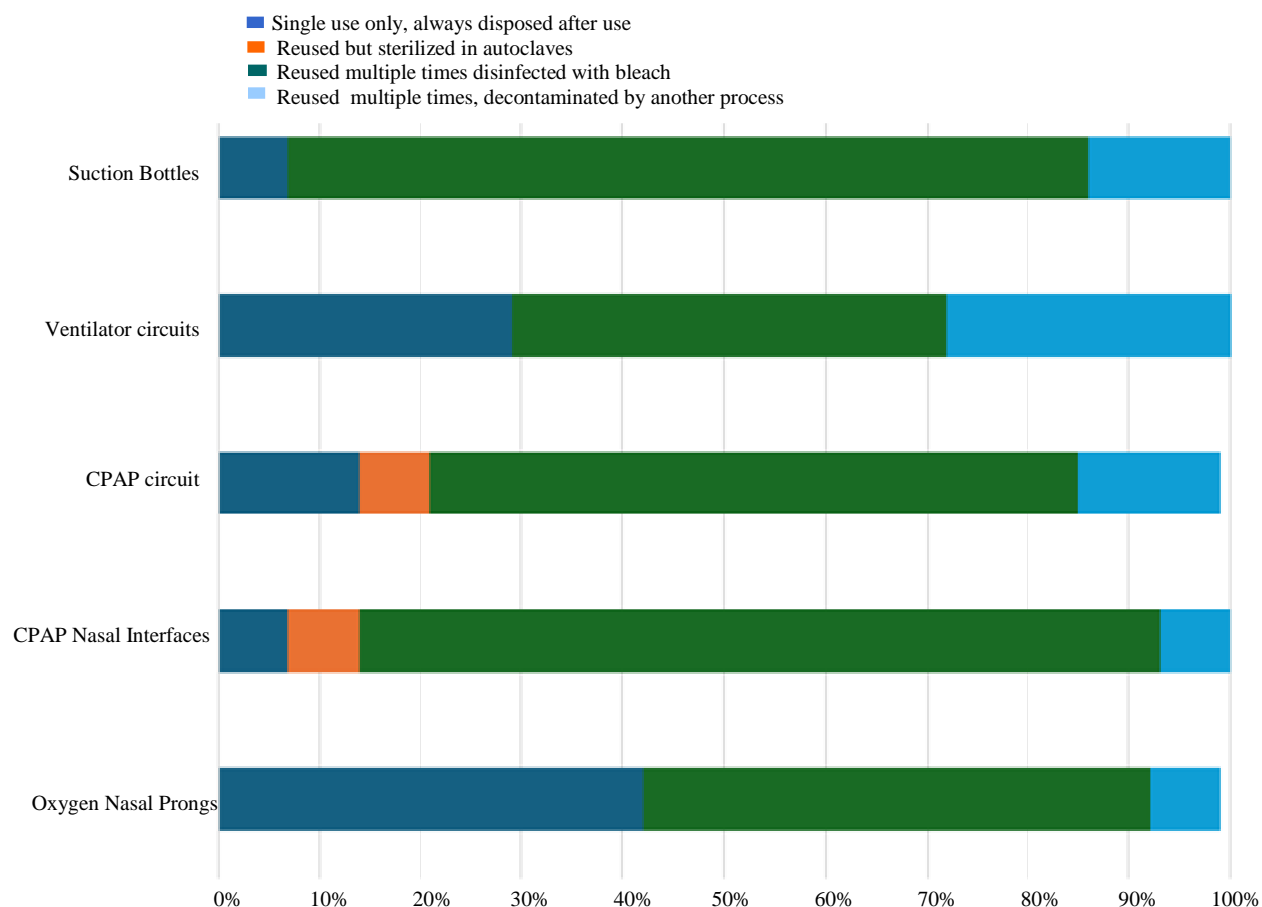
Oral and intravenous antibiotics were shared between neonates at four hospitals (29%). Parenteral fluids were shared between patients at six neonatal units (43%), with several respondents reporting prolonged (> 24 hours) use after opening and/or reconstituting medication and fluids (Table 2).

Table 1: Resources for infection prevention and control at 14 African Neonatal Network member hospitals

	#	%
Dedicated hand wash basins present in the neonatal unit	13	92
Running water available at the hand wash basins	9	64
Sink at entrance to unit or room has running water and soap and hand towels >90% of the time	6	43
Alcohol handrub available at the patient bedside	8	57
Facilities for sharps disposal available	13	93
Facilities available for equipment sterilization	13	93
Surgical masks available	11	79
N-95 respirators available	5	36
Face shields or eye protection available	5	36
Gowns available	10	71
Gloves available (non-sterile/sterile)	13	93

Table 3: Intravenous fluids and medication use practices at 14 African Neonatal Network member hospitals

	Intravenous fluids		Intravenous antibiotics		Oral medications	
	#	%	#	%	#	%
One vial is used for only one baby and is discarded within 24 hours of opening	5	36	4	29	2	14
One vial is used for one baby and may be used for more than 24 hours after opening	5	36	4	29	6	43
One vial is shared between multiple babies but is discarded within 24 hours after opening	4	29	6	43	4	29
One vial is shared between multiple babies and may be used for more than 24 hours after opening	0	0	0	0	2	14

Fig 1: Re-use and decontamination of respiratory consumables at 14 African neonatal network member hospitals

Discussion

HAIs and AMR are leading causes of neonatal morbidity and mortality in Africa. This paper described IPC resources and practices at ANN participating units in five African countries. Although most participating neonatal units had IPC and hospital cleaning guidelines, many lacked adequate infrastructure and consumables to support optimal IPC practice. Clinical care practices such as reprocessing of single-use items and sharing of parenteral fluids and medications, further highlight the major contribution of resource limitations to the burden of HAI in African neonatal units. Strengthening of IPC

resources (infrastructure, autoclaves, running water to NICUs and consumables), and IPC practices (hand hygiene, hospital cleaning, equipment reprocessing and medication/fluid use), is essential to reduce preventable harm from HAI in African neonatal units.

IPC guidelines, policies and practices

Our survey established that while most hospitals had existing IPC guidelines and policies, IPC practices for environmental cleaning, hand hygiene and linen management were sub-optimal. This finding resonates with a recent systematic review of IPC implementation barriers and facilitators in neonatal care across country income levels.⁹ In LMIC neonatal units, frequent barriers to

optimal IPC implementation included facility structural characteristics, available resources and staff capacity. Although staffing capacity for IPC was not specifically assessed in our survey, previous studies have ascertained major deficits in IPC to patient staffing ratios (recommended 1 IPC practitioner per 250 hospital beds) and limited IPC training of healthcare workers.^{10,11} Compounding the lack of IPC specialists, overall staffing and adequate nurse-to-patient ratios to follow optimal IPC practices is an area of needed attention. Tadesse *et al.* found that the median nurse-to-patient ratio in this ANN cohort to be four patients per nurse (IQR: 3, 5) on a day shift with 64% of sites adjusting the ratio for patient acuity.¹² The reports of observing vermin and animal faeces in/near the neonatal unit at over half of the facilities surveyed is very concerning given the known potential for these vectors to transmit pathogens in the health-care environment.^{13,14}

Diagnostic microbiology services and neonatal infection surveillance

It is encouraging that most of the neonatal units surveyed had access to onsite microbiology laboratories and an established system of monitoring neonatal sepsis cases over time. However, only two-thirds reported availability of local protocols for diagnosing and managing neonatal bloodstream infections and meningitis. In a recent large study conducted in 61 neonatal units in four African countries, only 6% of neonates had a blood culture specimen submitted despite over 70% of neonates receiving broad-spectrum antibiotic therapy for presumed sepsis. This finding contrasts with the report from this ANN cohort, which had higher utilization of blood cultures for sepsis management. Stevenson *et al.* found that 64.8% of all infants and 91.7% of infants born at < 32 weeks' gestation admitted to ANN neonatal units were treated with antibiotics. Among infants diagnosed with early-onset sepsis, 87% had a blood culture obtained; of those, 8.8% had a positive blood or cerebrospinal fluid culture. Additionally, 14.8% of infants were diagnosed with clinical sepsis after the first three days of which 88% had a blood culture obtained; of those, 40.1% had a positive blood or cerebrospinal fluid culture.¹⁵ In the ANN, only nine hospitals reported that blood culture and cerebrospinal fluid culture tests were "always available in the last month".¹⁶ Additionally, eight hospitals reported that parents have to pay for all tests.¹⁷

Given those circumstances, the proportion of infections with blood cultures are fairly high, although published data on outbreak reports from neonatal units in Africa outside of the ANN have shown underutilization of available laboratory services and underreporting of neonatal unit outbreaks.¹⁸ However, failure to submit blood cultures may contribute to excess sepsis deaths as this may delay initiation of effective antibiotic therapy. In addition, the lack of robust clinical and laboratory surveillance systems in most LMIC neonatal units is problematic, as it contributes to delayed recognition of out-

breaks and difficulty in making recommendations for effective empiric antibiotic therapy options.¹⁹

Hand hygiene

The World Health Organization recommends hand hygiene as a key intervention to reduce neonatal mortality. Several studies of hand hygiene have been associated with significant reduction in neonatal mortality.²⁰⁻²² Although this study established that most neonatal units had hand washing facilities available, only two-thirds had running water routinely available. In addition, alcohol-based hand rub was only regularly available at just over half the neonatal units. This lack of resources for water, sanitation and hygiene (WASH), has been reported from many other African healthcare facilities including Nigeria (water supply at only 14% of taps),²³ and from Malawi (no antiseptic hand soap available).²⁴ Another qualitative study from Malawi reported that the taps ran dry on approximately three days every week and there was no backup supply, hence water supply was intermittent.²⁵ These studies highlight some of the major infrastructural and engineering barriers to compliance with hand hygiene that must be addressed to reduce HAI in Africa neonatal units.

Re-use and sharing of equipment

We identified substantial re-use of equipment and single-use consumables across the facilities surveyed, especially for nasal cannulae and respiratory circuits. Reprocessing of equipment and consumables is often employed as a stopgap measure to ensure access to devices required for patient care, however this practice may lead to development of HAI if devices are inadequately or inappropriately re-processed. Re-use of single-use medical devices is a common practice globally, although more prevalent in LMICs where resources are perennially limited.²⁶ While this survey did not measure the impact of re-use or sub-optimal reprocessing on neonatal morbidity and mortality, it highlights the need to establish standardised guidelines and protocols for reprocessing of equipment and training of staff in LMICs, in order to reduce the undesirable practice significantly. Innovative solutions are needed to tackle the issue of device and equipment re-use in LMIC neonatal units - either through low-cost manufacturing of respiratory circuits or design on new methods to safely reprocess these devices.

Management of intravenous fluids and medications

The practice of sharing antibiotics and intravenous fluids between patients in the participating neonatal units is concerning, but is not a surprising finding in resource limited settings.^{10,26} Reports from the African continent have previously identified shared infusates (glucose, intravenous fluids, parenteral nutrition) as the outbreak source in neonatal units.²⁶ This practice is particularly problematic as intravenous infusates can easily become contaminated by bacterial and fungal pathogens, espe-

especially with multiple fluid access episodes and prolonged use after opening and/or reconstitution of medication and fluids. A fairly simple engineering solution to the problem of shared medical vials would be to use non-return valve multi-dose vial clave connectors to minimise contamination of medication vial contents. The practice of medication and intravenous fluid sharing on neonatal units should be discontinued owing to the high contamination risk and risk of preventable HAI in vulnerable neonates.

The generalisability of our study findings is limited by the small number of units, although mitigated somewhat by the inclusion of units in five African countries. Although the findings are not novel, they underscore the critical importance of IPC programmes in ensuring patient safety and improved outcomes in African neonatal units.

Conclusions

Although most participating neonatal units had IPC and hospital cleaning guidelines, many lacked adequate infrastructure and consumables to support optimal IPC practice. Clinical care practices such as reprocessing of single use items and sharing of parenteral fluids and medication, further highlight the major contribution of

resource limitations to the burden of healthcare associated infections in African neonatal units. To address the high rates of neonatal morbidity and mortality caused by preventable HAI, resources to support IPC programmes, infrastructure and equipment in neonatal units should be prioritized by institutions and Ministries of Health.

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