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REVIEW ARTICLE

CENTRAL MEDICAL STORES AND ESSENTIAL MEDICINE AVAILABILITY IN SUB-SAHARAN AFRICA: A SYSTEMATIC REVIEW WITH A FOCUS ON TANZANIA'S MEDICAL STORES

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Abstract

Background: Central medical stores are the principal route by which many low- and middle-income countries seek to ensure that essential medicines reach public hospitals, yet the evidence on how they perform and how this affects patient care remains fragmented.
Objectives: To examine how the performance of central medical stores relates to the availability of essential medicines and patient outcomes in tertiary and referral hospitals across sub-Saharan Africa, with Tanzania as the focus and Kenya, Uganda, and Ghana as comparators.
Methods: This systematic review was conducted in line with the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidance. Open-access literature was searched, and only sources carrying a digital object identifier were kept.
Results: In Tanzania, the availability of essential health commodities increased by 12.6% (95% confidence interval 9.6 to 15.6) following Global Fund-supported reforms, and tracer medicine availability in a pilot region went from 69% to 94% once a prime vendor system was introduced. Central store order fulfillment stood at 58.6% in a Tanzanian baseline survey and between 51% and 60% at a Kenyan referral hospital. In Uganda, 84% of 128 facilities reported at least one stock-out during the previous six months, while introduction of an online ordering portal coincided with an increase in order fill rate from 72.6% to 81.4% across 54 hospitals. In Ghana, the availability of 65 essential medicines at a regional store declined from 100% to 52% after framework agreements were adopted (preprint). None of the studies used a randomized or matched comparator, and none recorded hospital mortality together with central store performance.
Conclusion: Reforms coincided with improved availability in Tanzania and Uganda but with reduced availability in Ghana, indicating that design and implementation both count. Evidence connecting central store performance to patient outcomes in tertiary hospitals is limited and indirect.
Keywords: central medical stores, essential medicines, pharmaceutical supply chain, stock-out, sub-Saharan Africa.

INTRODUCTION

Dependable access to essential and emergency medicines continues to be a major weakness in the health systems of low- and middle-income countries (LMICs). Reported mean availability of generic medicines in the public sector across World Health Organization regions lies between 29.4% and 54.4%, and inefficient purchasing, distribution, and price mark-ups are named as the chief obstacles[1]. Where public-sector supplies run out, patients are often driven to more expensive private providers, which erodes equity and disrupts emergency care.

Most LMIC governments rely on central medical stores (CMS) to assure that medicines are available in public facilities. A CMS typically handles product selection, quantification, procurement, warehousing, distribution, and inventory management, normally within one national or semi-autonomous body. Concentrating these functions also concentrates risk, because a failure at the central agency exposes every facility downstream simultaneously[2].

In Tanzania, the Medical Stores Department (MSD) is the national body charged with procuring, storing, and supplying medicines and other health commodities to public facilities, and shortages at the point of care have repeatedly been linked to stock-outs at MSD[3]. Similar agencies exist in Kenya (Kenya Medical Supplies Authority, KEMSA), Uganda (National Medical Stores, NMS), and Ghana (regional and central medical stores). Each country has introduced reforms, but the evidence on their impact is dispersed across operational reports, cross-sectional surveys, and before-and-after evaluations, and seldom links central store performance to patient outcomes in hospitals.

The aim of this systematic review was therefore to bring together evidence on how the supply chain performance of CMS-based systems relates to (1) the availability of essential and emergency medicines and (2) patient care outcomes in tertiary and referral hospitals in sub-Saharan Africa, with particular attention to MSD Tanzania and comparison with KEMSA, NMS, and the Ghanaian medical stores model.

MATERIALS AND METHODS

Design and reporting standard

This review was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidance[3]. The studies retrieved differed in design and in the denominators of their outcomes, which ruled out pooled effect-size estimation (see "Data extraction and approach to synthesis"). The work is therefore presented as a systematic review with a narrative and descriptive quantitative synthesis rather than a meta-analysis, avoiding any implication of statistical pooling that the data cannot support.

Registration

The review protocol was not registered.

Eligibility criteria

Eligibility followed the population, exposure, comparator, outcomes, and study design (PICOS) framework (Table 1). Only sources with a verifiable digital object identifier (DOI) were retained, and institutional reports and web pages lacking a DOI were left out of the evidence base.

CMS, central medical stores; KEMSA, Kenya Medical Supplies Authority; MSD, Medical Stores Department; NMS, National Medical Stores; PICOS, population, exposure, comparator, outcomes, study design.

Information sources and search strategy

The search covered open-access biomedical literature and preprint servers, among them PubMed-indexed journals, BioMed Central/Springer Nature, Frontiers, and medRxiv, as well as institutional grey literature such as World Bank and ThinkWell Global reports. The core Boolean strategy linked CMS/MSD terms with medicine-availability terms and facility-level terms:

("Medical Stores Department" OR "Central Medical Stores" OR "medical supply agency" OR "pharmaceutical supply chain") AND ("essential medicines" OR "emergency medicines" OR "medicine availability" OR "stock out" OR "drug shortage") AND ("tertiary hospital" OR "referral hospital" OR "health facility").

Table 1: Eligibility criteria (PICOS).

Element	Specification
Population	Tertiary, referral, teaching, and specialised hospitals, and public health facilities supplied through a national or central medical stores system
Exposure	CMS-based pharmaceutical supply chain systems (MSD Tanzania, KEMSA Kenya, NMS Uganda, and Ghana regional/central medical stores) and documented reforms to these systems
Comparator	Pre-reform versus post-reform periods within the same system; facilities or regions with versus without a specific intervention (for example, electronic logistics management information system, prime vendor, framework agreements). Randomised or independent-system comparator studies were not identified and are not claimed
Outcomes	Primary: essential/tracer medicine availability (%), stock-out frequency, order fulfilment rate. Secondary: procurement lead time, redistribution compliance, electronic logistics management information system penetration and, where reported in the broader literature, treatment delay and malaria morbidity and mortality
Study design	Interrupted time series, retrospective before-and-after evaluations, cross-sectional facility surveys, and mixed-methods assessments with quantitative stock-record data

CMS, central medical stores; KEMSA, Kenya Medical Supplies Authority; MSD, Medical Stores Department; NMS, National Medical Stores; PICOS, population, exposure, comparator, outcomes, study design.

Supplementary searches specific to Kenya (KEMSA), Uganda (National Medical Stores), and Ghana (Central/Regional Medical Stores) were also run, along with a separate search on the relationship between stock-outs and patient outcomes. The subscription-only databases listed in the original protocol (Embase, Scopus, Web of Science, and Cochrane Library) could not be accessed and were not searched.

Data extraction and approach to synthesis

From each study we recorded the country, CMS system, study design, facility level, sample size (number of facilities or records), the availability or fulfillment metric and its value, and the reform or intervention, where relevant. We did not conduct a formal meta-analysis (pooled proportions or effect sizes with 95% confidence intervals, I^2, tau^2, Egger's regression, and forest and funnel plots), for two reasons. First, the outcome metrics were defined differently across studies (tracer-medicine availability, order fulfillment, and facility-reported stock-out incidence).

Table 2: Characteristics of the included studies.

Country (system)	Design and scope	Key metric(s) reported	Ref.
Tanzania (MSD)	Interrupted time series with 41 key informant interviews; national, health zones	Availability of essential health commodities increased by 12.6% (95% CI 9.6-15.6) after the Global Fund-supported reforms, with a further monthly rise of 0.2% relative to the pre-intervention trend	1
Tanzania (MSD and prime vendor)	Baseline survey (Dodoma region, 2011) and programme evaluation; regional, scaled nationally	53% availability, 47% stock-out (24 tracer medicines), and 58.6% order fulfilment at baseline; tracer availability 69% (2014) to 94% (2018) in the pilot region after prime vendor introduction	2
Kenya (KEMSA)	Cross-sectional mixed-methods study; Kitui County Referral Hospital; 155 tracer commodities in 22 departments	51-60% order fulfilment; inventory-trained staff associated with higher availability (p=0.029)	5
Uganda (NMS)	Cross-sectional; 128 public and private not-for-profit facilities in 48 districts, all levels including national referral hospitals	84% of facilities reported a stock-out in the prior 6 months; 84% used some form of LMIS and 6% an eLMIS; 42% had computer hardware	6
Uganda (NMS)	Mixed-methods; Mbale district; 55 facility-level respondents and 5 district key informants	About one-third (33%) of facilities complied with EMHS redistribution guidelines	7
Uganda (NMS)	Retrospective before-and-after; 54 public hospitals; FY 2020-21 versus FY 2022-23	Order fill rate 72.6% to 81.4% (p=0.003); ordering timeliness 87.6% to 96.9%; delivery timeliness 69.6% to 80.3%; stock-out days for TLD 20.4 to 14.5	8
Uganda (NMS)	Exploratory equity analysis of EMHS funding allocation; 43 hospitals and HC IV facilities and 44 lower-level facilities	Allocation per patient at HC IV ranged from US$0.25 to US$2.14; 43% of facilities had optimal stock levels, 27% were under stocked, and 30% overstocked	9
Ghana (Upper East Regional Medical Stores)	Retrospective stock-record review (2015-2024) with stakeholder interviews; preprint	Availability of 65 essential medicines 100% (2015-2016) before framework agreements, 82% after introduction (2017), and 52% by 2024; lead time 20-21 days to 29 days	10

CI, confidence interval; eLMIS, electronic logistics management information system; EMHS, essential medicines and health supplies; FY, fiscal year; HC IV, health centre level IV; KEMSA, Kenya Medical Supplies Authority; LMIS, logistics management information system; MSD, Medical Stores Department; NMS, National Medical Stores; TLD, tenofovir/lamivudine/dolutegravir. The Dodoma baseline figures derive from an unpublished project report cited in the source article.

Second, the raw numerators and denominators required for valid pooling were not consistently available, since the retrieved sources give study-level summary percentages (Table 2).

Risk of Bias

Given that cross-sectional, before-and-after, and interrupted time series designs predominated, risk of bias was planned to be appraised using the Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool[4] for before-and-after and interrupted time series studies and an adapted Newcastle-Ottawa Scale for cross-sectional facility surveys. Study-level appraisal needs full texts, but only abstracts and excerpts were accessible for part of the evidence, so a formal risk-of-bias table was not completed.

Ethical considerations

This review drew solely on published, publicly available aggregate data and did not involve human participants, human tissue, or animals; ethics approval and informed consent were therefore not needed.

RESULTS AND DISCUSSION

Study characteristics

Eight studies from four countries were included (Table 2). Two came from Tanzania: an interrupted time series with key informant interviews assessing the Global Fund-supported MSD reforms[1], and a programme evaluation of the Jazia prime vendor system that also reports the Dodoma baseline survey[2]. One came from Kenya, a cross-sectional mixed-methods study at Kitui County Referral Hospital[5]. Four came from Uganda: a national facility survey[6], a mixed-methods study in Mbale district[7], a retrospective before-and-after evaluation of an online ordering portal in 54 public hospitals[8], and an analysis of equity in funding allocation[9]. One came from Ghana, a stock-record review with interviews on framework agreements in the Upper East Region, available as a preprint[10]. Two additional articles, a review of malaria stock-outs and a perspective on medicine access, were used only to address the patient-outcome question[11,12].

Medicine availability and stock-out patterns

Across the periods studied, availability and fulfillment were generally poor. The Dodoma baseline recorded 53% availability and 58.6% order fulfillment by MSD,[2] and KEMSA fulfilled 51-60% of orders at Kitui County Referral Hospital[5]. In the Ugandan national survey, 84% of facilities had experienced a stock-out within the previous six months, citing a sudden surge in demand (59%), delivery gaps or late deliveries (40%), and mismatches between orders and deliveries (35%) as the main causes[6]. The comparable fulfillment figures in Tanzania and Kenya come from different

facility levels and years, but we hypothesize that they point to a common structural bottleneck (timing of funding disbursement, forecasting accuracy, and distribution logistics) operating in administratively separate national systems, rather than to a country-specific anomaly.

Association between reform and availability

The direction of the association between reform and availability varied by country wherever before-and-after data were available. In Tanzania, an interrupted time series analysis of the Global Fund-supported MSD transformation showed that the availability of essential health commodities rose by 12.6% (95% confidence interval [CI] 9.6-15.6) after the reforms, together with an additional monthly increase of 0.2% (95% CI 0.0-0.3) over the pre-intervention trend[1]. In the Dodoma pilot region, tracer-medicine availability climbed from 69% in 2014 to 94% in 2018 once the prime vendor system began to supplement MSD supply, and the system was later extended to all 26 regions of mainland Tanzania[2]. In Uganda, introduction of the online ordering portal coincided with improvements in order fill rate (72.6% to 81.4%), ordering timeliness (87.6% to 96.9%), and delivery timeliness (69.6% to 80.3%) between fiscal years 2020-21 and 2022-23. Availability of selected HIV, TB, and malaria commodities also increased (for example, TLD from 90.5% to 96.4%), although not every commodity showed a significant change[8].

Ghana stands out as the exception. In the Upper East Region, the 65 essential medicines were 100% available at the regional store in 2015-2016, before framework agreements, but availability dropped to 82% after they began in 2017 and to 52% by 2024, with lead times growing longer; stakeholders blamed late payment of suppliers, inflexible rules that barred emergency purchases outside the agreements, and the lack of a monitoring system[10]. This result rests on a preprint and a single regional store, yet it demonstrates that reform does not automatically bring benefit. None of the evaluations had a randomized or externally matched comparison group. All rely on within-system before-and-after comparison, which cannot completely rule out secular trends, such as concurrent changes in donor financing or disease-programme commodity pushes, as alternative explanations.

Digital systems

Use of electronic logistics management information systems (eLMIS) stayed low even where some type of stock tracking was routine. In the Ugandan facility survey, 84% of sites used a logistics management information system (LMIS) of some kind, yet only 6% used an electronic one and only 42% had computer hardware[6]. Electronic systems are how real-time stock data can feed into central procurement decisions, so this shortfall bears directly on the accuracy of forecasting and quantification. Because such systems were almost absent at facility level, it is hard to say how much of the observed availability gap reflects failures at the central store as opposed to failures in facility-level reporting.

Redistribution and equity mechanisms

In Mbale district, Uganda, about one-third (33%) of the facilities surveyed followed guidelines on redistributing unexpired stock from over-supplied to under-supplied facilities; respondents who reported that the guidelines had never been shared were 88% less likely to comply, and those unaware that redistribution funds were released on time were 68% less likely to comply[7]. A separate national analysis showed that facilities at the same level of the health system, nominally entitled to equal budget treatment, received widely different per-patient medicine funding: at the highest-level health centres, allocations ranged from US$0.25 to US$2.14 per patient, and only 43% of all facilities held optimal stock levels[9]. In Uganda at least, availability gaps are thus shaped not only by the performance of central procurement and distribution but also by downstream allocation and redistribution mechanisms. This has policy relevance, as improving the central store alone would not address this driver.

Link to patient outcomes

The most direct quantitative connection between stock-outs and patient outcomes found in this review comes from malaria case management. A lack of first-line artemisinin-based combination therapy has been associated with greater malaria morbidity and mortality, since patients unable to start treatment promptly face a higher risk of progressing to severe disease, with young children and pregnant women most at risk[11]. Wider assessments of medicine access in sub-Saharan Africa describe a comparable sequence wherever stock-outs happen: late treatment initiation, incomplete treatment, interruptions in treatment, disengagement from care, and increased out-of-pocket spending[12]. This evidence comes from a disease-specific clinical and epidemiological literature and from a policy perspective, not from the CMS-specific operational studies in Table 2. None of the included MSD, KEMSA, NMS, or Ghana studies measured mortality or morbidity directly alongside availability metrics. The link between CMS performance and patient mortality or morbidity is therefore supported only indirectly, by reading separate bodies of literature together, and not by any single study that measured both.

This review found that shortfalls in availability and fulfillment were widespread across the systems studied: order fulfillment of about 50-60% in Tanzania and Kenya, and 84% of Ugandan facilities reporting at least one stock-out within six months. Reforms in Tanzania (donor-supported institutional transformation and a prime vendor system) and Uganda (digital self-service ordering) were associated with improvement in direction, while Ghana's framework-agreement approach was associated with declining availability in the single region evaluated. The main evidence gap is that no CMS-specific study followed availability changes through to emergency care outcomes at hospital level.

The role of MSD

The experience of MSD illustrates both the vulnerability and the capacity for reform of a single-agency national CMS model. Its operations started to

weaken around 2006, leading to frequent stock-outs of essential medicines in public facilities, and a 2011 survey of HIV/AIDS care and treatment clinics found antiretroviral stock-outs at up to 80% of sites during the previous 12 months[1]. The shortfall has been ascribed to growing demand for services, late release of funds, weak governance, staff shortages, and working-capital constraints. Tanzania responded through at least two documented reform pathways: an institutional transformation supported by the Global Fund, evaluated through interrupted time series analysis and 41 key informant interviews, and the Jazia prime vendor system, a public-private partnership in which a private supplier complements national supply when MSD is out of stock, and which expanded from a regional pilot to national scale-up covering 185 councils and 5381 health facilities[2]. The transformation evaluation also warned that growing government receivables could endanger the sustainability of the gains, which identifies predictable financing as a central determinant of lasting improvement[1].

Comparative CMS models

The four systems differ in structure. MSD and NMS are single national agencies; NMS has sole national responsibility for purchasing, warehousing, and distributing medicines, and higher-level hospitals order about every two months[9]. KEMSA is likewise national; in Kenya, the only study that met our DOI criterion reported delays and 51-60% order fulfillment at a county referral hospital, made worse by dependence on manual inventory systems, although departments with inventory-trained staff had significantly higher availability (p=0.029)[5]. Evidence on KEMSA's broader reform trajectory is found mostly in institutional reports and web sources lacking persistent identifiers, which we excluded, so conclusions about Kenya are limited accordingly. Ghana's supply operates through regional medical stores that follow national Ministry of Health policy while coordinating with the Central Medical Stores; in the Upper East Region, pre-agreed national supplier contracts ("framework agreements") were assessed against a basket of 65 essential medicines through stock-record audits and staff interviews[10]. We hypothesize that institutional form (single agency or framework contracting) matters less than the quality of execution, notably predictable financing, prompt payment of suppliers, visibility of digital data, and staff capacity, whichever form is adopted. The Ghanaian findings in particular suggest that contracting mechanisms need flexibility for emergency purchases, as well as monitoring, to prevent availability from worsening.

Health system and policy implications

Order fulfillment rates of 50-60% at baseline in Tanzania and at the Kenyan referral hospital imply that around 40-50% of ordered items were not supplied by the central store in those settings. A gap of this size could plausibly affect emergency and routine care irrespective of how well facilities manage stock downstream. The low eLMIS penetration in Uganda (6%) highlights a specific, actionable lever: digital stock visibility, which supports the accuracy of forecasting and quantification, remains an unresolved gap rather than a solved problem.

Limitations of the study

This review has four main limitations. First, access to subscription databases (Embase, Scopus, Web of Science, and Cochrane Library) was not available, so the real evidence base is probably larger than the eight studies synthesized here, and a formal PRISMA flow diagram of record counts could not be produced. Second, no formal meta-analysis was undertaken, for the statistical reasons set out in the Methods; the descriptive percentages in Table 2 should not be read as pooled effect estimates, and a study-by-study risk-of-bias assessment was not completed. Third, limiting the evidence to sources with a DOI excluded relevant institutional reports, especially for Kenya.

Future research priorities

Studies that measure CMS-level operational performance (fulfillment rate and stock-out duration) and facility-level clinical outcomes (treatment delay, case fatality, and complication rates) together in the same population would address the largest gap identified here. Where raw facility-level numerators and denominators can be obtained through full-text review of primary studies, a random-effects meta-analysis of medicine availability proportions across MSD, KEMSA, NMS, and Ghana's medical stores would be a logical next step and is methodologically feasible in principle.

CONCLUSIONS

Evidence from Tanzania, Kenya, Uganda, and Ghana points to considerable shortfalls in essential-medicine availability and order fulfillment at or through central medical stores (about 50-60% order fulfillment in Tanzania and Kenya, and 84% of Ugandan facilities reporting a stock-out within six months). Reforms in Tanzania and Uganda coincided with improvement in before-and-after comparisons, while framework contracting in one Ghanaian region coincided with decline, so the design and implementation of reforms count. Strengthening MSD and similar CMS operations through predictable financing, governance reform, and broader use of electronic logistics information systems can be justified on availability grounds alone. Evidence that directly connects CMS performance to patient mortality and morbidity in tertiary hospitals remains indirect, and addressing this gap should be a priority for future research.

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AUTHOR'S CONTRIBUTION

Ndetico K: conceptualization, supervision, writing, review and editing. **Barugahale LP:** methodology,

investigation, writing original draft. **Mkama RA:** investigation, data curation, writing original draft. **Mbunda VJ:** formal analysis, validation, visualization. **Malifimbo J:** data curation, formal analysis, writing, review, editing. **Mwakatuma E:** methodology, investigation, resources. **Mandilindi ES:** review, conceptualization, editing. **Wambwe EC:** validation, visualization, supervision. All authors read and approved the final manuscript.

DATA AVAILABILITY

The related author can provide the empirical data supporting the study's conclusions upon request.

CONFLICT OF INTEREST

No conflict of interest associated with this work.

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