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Beyond the Stock Card: Assessing Advanced Inventory Monitoring Practices among Pharmaceutical Supply Chain Personnel in Four States of South-South Nigeria

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Abstract- Inventory management is frequently reduced, in health-systems research from sub-Saharan Africa, to a single question of which recording medium a facility employs — a stock card, a ledger, or a computer. This framing overlooks the substance of what a functioning inventory system actually requires its custodians to track: current stock on hand, historical consumption, losses and adjustments, supplier lead times, minimum and maximum stock thresholds, shipment and handling schedules, and provision for safety stock against demand variability. Using previously unreported items from a 2015 cross-sectional survey of 150 health professionals across registered hospital and community pharmacy settings in Rivers, Bayelsa, Akwa-Ibom and Cross River States, this study examined the extent to which these seven monitoring components were practised, and whether their practice varied by state, sector of employment, and area of practice. Current stock levels were the most consistently monitored component (92.0% of respondents reporting always or sometimes doing so), while shipment and handling scheduling was the least (60.7%), with supplier lead-time tracking, stock-level thresholds and safety-stock provision occupying an intermediate band (70.0–74.7%). Chi-square analysis showed that practice of five of the seven components varied significantly by state ($p<0.05$), including a pronounced Rivers–Cross River divide in the monitoring of maximum/minimum stock levels (96.0% versus 28.0% positive practice) and in the use of computerised stock-keeping methods ($\chi^2=17.8$, $p=0.038$). No significant variation was detected by sector of employment or by area of practice. The findings indicate a hierarchy of inventory practice in which facilities readily track what is immediately visible — current stock — but are considerably less consistent in the anticipatory components of inventory control that guard against stock-outs and wastage, and that this deficit is patterned by geography rather than by institutional type.

Keywords: inventory management, logistics cycle, pharmaceutical supply chain, stock control, nigeria

I. INTRODUCTION

Inventory management sits at what USAID's DELIVER Project literature terms the "heart of the logistics cycle" — the point at which product availability data, consumption patterns and resupply decisions converge to determine whether medicines reach the patients who need them [1]. A pharmaceutical supply chain can perform adequately at the levels of product selection and procurement and still fail at the point of care if the intervening inventory functions are neglected. These functions extend well beyond the recording of goods received and issued: they include the routine reconciliation of stock on hand against consumption, the documentation of losses arising from expiry, damage or pilferage, the tracking of supplier and donor lead times so that reorder points can be set with confidence, the maintenance of defined maximum and minimum stock levels appropriate to a facility's throughput, the scheduling of shipment and handling arrangements, and deliberate provision for safety stock to buffer against the demand variability that is characteristic of health commodity use [2,3].

Empirical attention to these specific components in the West African pharmaceutical supply chain literature has been limited. Existing Nigerian studies of supply chain knowledge and practice, including a recent survey of health professionals across four South-South Nigerian states, have tended to report inventory management chiefly in terms of the physical medium used to record stock — stock cards, ledgers, or computerised systems — and the perceived effectiveness of delivery distribution [4]. While informative, this framing does not disaggregate the more analytically demanding components of inventory control, namely the extent to which lead times, stock thresholds, shipment schedules and safety-stock considerations are actively monitored by front-line personnel. These components matter because they are the operational levers through which the well-documented “bullwhip effect” — the amplification of demand variability as it propagates upstream through a supply chain — is either dampened or exacerbated [5,6]. A facility that tracks stock on hand without reference to consumption trends, lead times or safety margins is poorly positioned to anticipate shortage before it occurs, however diligently that facility records its stock movements.

This study draws on items collected as part of a broader 2015 survey of pharmaceutical supply chain knowledge and practice among health professionals in Rivers, Bayelsa, Akwa-Ibom and Cross River States of Nigeria, the headline findings of which — knowledge of supply chain concepts, forecasting information sources, procurement channels, and delivery ratings — have been reported elsewhere [4]. The present analysis addresses items from that same instrument concerning current inventory levels, consumption monitoring, losses and adjustments, lead times, maximum and minimum stock levels, shipment and handling schedules, and safety-stock provision, none of which were examined in the earlier report. The objective was twofold: first, to characterise the extent to which each of these seven inventory-control components is practised among respondents; and second, to determine whether this practice differs systematically by state, sector of employment (government or private) and area of practice (hospital or community pharmacy).

II. METHODS

Study Design and Setting

This is a secondary analysis of data from a cross-sectional descriptive survey conducted between February and July 2015 in registered hospital and community pharmacy practice settings in Rivers, Bayelsa, Akwa-Ibom and Cross River States, South-South Nigeria. The parent study, its sampling frame, and its principal descriptive findings are reported in Buseri, Aremu and Suleiman [4]; the present paper analyses a distinct set of instrument items from the same dataset that were not addressed in that report.

Study Population and Sampling

The study population comprised health professionals responsible for supply chain management of pharmaceuticals and related health commodities in hospital and community pharmacies. A sample size of 150 was derived using a standard sample size calculator at 95% confidence level and 5% confidence interval, based on an estimated 238 registered practice settings across the four states [7], and respondents were recruited by convenience sampling in proportion to the density of practice settings in each state.

Data Collection Instrument

Data were collected using a structured, pre-tested, self-administered questionnaire of 29 items, supplemented by guided face-to-face interview where necessary. The instrument's second part, from which the present analysis is drawn, included a discrete section on inventory management modelled on the components of the logistics cycle described by USAID's DELIVER Project [1], with responses to each component recorded on a three-point frequency scale of “Always”, “Sometimes” or “Never”, together with a “No Response” category. For analytical purposes, and consistent with the convention adopted in the parent study, responses of “Always” and “Sometimes” were combined as a positive indication of practice, while “Never” and “No Response” were combined as a negative indication.

Variables Analysed

Seven inventory-control items, not reported in the parent publication, form the basis of this analysis: monitoring of current stock on hand; monitoring of consumption; documentation of losses and adjustments; tracking of supplier or donor lead times; maintenance of maximum and minimum stock levels; scheduling of shipment and handling; and provision for safety stock. Two further items reported descriptively in the parent study — the stock-keeping method employed (stock card, ledger or computer) and the respondent's rating of facility delivery distribution — are re-examined here inferentially, disaggregated by state, to test for association not previously assessed.

Data Analysis

Data were analysed in Python (pandas 2.x, SciPy 1.x) following extraction from the original SPSS (version 20) dataset. Descriptive statistics (frequencies and percentages) were computed for each inventory-control item overall and by state, sector of employment, and area of practice. Associations between categorical variables were tested using Pearson's chi-square test of independence; a two-tailed p-value of less than 0.05 was taken to indicate statistical significance. Where expected cell counts were low, particularly for the state-disaggregated comparisons involving the smaller Akwa-Ibom and Cross River strata (n=25 each), results are interpreted with appropriate caution.

Ethical Approval

Ethical approval for the parent study was obtained from the Ethics Committee of the Niger Delta University Teaching Hospital, Okolobiri, Bayelsa State (reference NDUTH/REC/0016/2016), and all respondents provided informed consent prior to participation. As a secondary analysis of de-identified, previously collected data, no additional ethical clearance was sought for the present study.

III. RESULTS

Overall Pattern of Inventory-Control Practice

Table 1 presents the frequency distribution of responses across the seven inventory-control components among the 150 respondents. Monitoring of current stock on hand was the most consistently practised component, with 92.0% of respondents indicating that they always or sometimes undertook it, followed closely by consumption monitoring (89.3%) and the documentation of losses and adjustments (86.0%). Practice declined markedly for the more anticipatory components of inventory control: supplier or donor lead times were monitored by 74.0% of respondents, maximum and minimum stock levels by 74.7%, provision for safety stock by 70.0%, and shipment and handling schedules by only 60.7% — the lowest figure recorded for any of the seven components. Notably, current stock on hand was the only component for which no respondent selected “Never”, whereas one in six respondents (16.7%) explicitly reported never scheduling shipment and handling.

Table 1: Frequency Distribution of Advanced Inventory-Control Practices; N = 150

Inventory-Control Component	Always N(%)	Sometimes N(%)	Never N(%)	No Response N(%)	Positive Practice N(%)
Current stock on hand	119 (79.3)	19 (12.7)	0 (0.0)	12 (8.0)	138 (92.0)
Consumption data	95 (63.3)	39 (26.0)	2 (1.3)	14 (9.3)	134 (89.3)
Losses & adjustments	78 (52.0)	51 (34.0)	9 (6.0)	12 (8.0)	129 (86.0)
Maximum/minimum stock levels	56 (37.3)	56 (37.3)	6 (4.0)	32 (21.3)	112 (74.7)
Supplier/donor lead times	53 (35.3)	58 (38.7)	8 (5.3)	31 (20.7)	111 (74.0)
Need for safety stock	52 (34.7)	53 (35.3)	12 (8.0)	33 (22.0)	105 (70.0)
Shipment & handling schedules	43 (28.7)	48 (32.0)	25 (16.7)	34 (22.7)	91 (60.7)

Positive Practice = Always + Sometimes.

Variation by State

Table 2 sets out the proportion of respondents in each state reporting positive practice for each component, together with the results of chi-square testing. Practice of five of the seven components varied significantly by state. The clearest pattern was observed for maximum/minimum stock level monitoring, where positive practice ranged from 96.0% in Rivers State to 28.0% in Cross River State (χ^2=48.81, df=3, $p<0.001$), and for provision for

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safety stock, which ranged from 86.0% in both Bayelsa and Rivers States to 32.0% in Cross River State (χ^2=37.43, p<0.001). Shipment and handling scheduling followed a similar pattern, with Cross River again recording the lowest positive practice (24.0%) against 72–74% in Bayelsa and Rivers (χ^2=22.18, p<0.001). Monitoring of current stock on hand and of supplier lead times likewise differed significantly by state (p=0.001 in each case), with Rivers State recording the highest levels of practice throughout (96–100% across components) and Cross River and, to a lesser extent, Akwa-Ibom recording the lowest. Documentation of losses and adjustments was the sole component that did not differ significantly by state (χ^2=0.17, p=0.983), remaining consistently high (84–88%) across all four states.

Table 2: Positive Practice (%) of Advanced Inventory-Control Components by State

Inventory-Control Component	Akwa Ibom (n=25) %	Bayelsa (n=50) %	Cross River (n=25) %	Rivers (n=50) %	χ^2 (df=3)	p-value
Current stock on hand	84.0	96.0	76.0	100.0	16.30	0.001
Consumption data	84.0	86.0	80.0	100.0	9.59	0.022
Losses & adjustments	84.0	86.0	88.0	86.0	0.17	0.983
Supplier/donor lead times	56.0	80.0	52.0	88.0	16.53	0.001
Maximum/minimum stock levels	56.0	86.0	28.0	96.0	48.81	<0.001
Shipment & handling schedules	48.0	74.0	24.0	72.0	22.18	<0.001
Need for safety stock	44.0	86.0	32.0	86.0	37.43	<0.001

Positive Practice = Always + Sometimes, expressed as a percentage of respondents in the relevant state.

Stock-Keeping Method by State

The stock-keeping method reported by respondents also varied significantly by state (χ^2=17.77, df=9, p=0.038; Table 3). Manual stock or bin cards remained the predominant method across all four states, but computerised stock-keeping was reported by three times as many respondents in Rivers State (30.0%) and Bayelsa State (24.0%) as in Akwa-Ibom (8.0%) and Cross River (4.0%). By contrast, the respondent's subjective rating of facility delivery distribution did not differ significantly by state (χ^2=15.04, df=12, p=0.240), suggesting that perceived delivery adequacy and the more granular, behaviourally anchored inventory-control components captured in this study do not necessarily track one another.

Table 3: Stock-Keeping Method by State

State	Stock/Bin Card %	Stock Ledger %	Computer %	No Response %
Akwa Ibom (n=25)	72.0	12.0	8.0	8.0
Bayelsa (n=50)	56.0	18.0	24.0	2.0
Cross River (n=25)	84.0	8.0	4.0	4.0
Rivers (n=50)	64.0	6.0	30.0	0.0

Variation by Sector and Area of Practice

In marked contrast to the state-level findings, none of the seven inventory-control components differed significantly by sector of employment (government versus private) or by area of practice (hospital versus community pharmacy); all chi-square p-values exceeded 0.23 (Table 4). This was consistent across both the more routinely practised components, such as monitoring of current stock and consumption, and the less consistently practised anticipatory components, such as shipment scheduling and safety-stock provision.

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Table 4: Positive Practice (%) of Advanced Inventory-Control Components by Sector and Area of Practice

Inventory-Control Component	Government %	Private %	Hospital Pharm. %	Community Pharm. %	p (sector / practice)
Current stock on hand	93.4	90.1	94.8	89.9	0.671 / 0.480
Consumption data	89.5	88.7	91.4	85.5	1.000 / 0.456
Losses & adjustments	88.2	84.5	91.4	87.0	0.686 / 0.611
Supplier/donor lead times	73.7	73.2	77.6	72.5	1.000 / 0.648
Maximum/minimum stock levels	72.4	77.5	75.9	72.5	0.602 / 0.817
Shipment & handling schedules	55.3	66.2	58.6	62.3	0.235 / 0.808
Need for safety stock	72.4	67.6	75.9	66.7	0.653 / 0.347

IV. DISCUSSION

The gradient observed across the seven inventory-control components — from near-universal monitoring of current stock on hand to comparatively sparse attention to shipment scheduling and safety-stock provision — is consistent with a pattern noted in the broader health logistics literature, whereby facility staff attend most readily to the components of inventory control that are immediately visible and low in interpretive burden, and least readily to those that require anticipation of future demand and supply variability [2,8]. Tracking stock on hand is largely a matter of observation; tracking lead times, safety stock and shipment schedules requires the synthesis of historical data, supplier performance and demand forecasts, a more demanding analytical task that this study suggests is not uniformly undertaken even where basic stock monitoring is well established.

This distinction matters because it is precisely the anticipatory components — lead times, stock thresholds and safety margins — that determine a facility's capacity to avert the amplification of demand variability described in the supply chain literature as the bullwhip effect [5,6]. A facility that reconciles its stock ledger meticulously but does not track supplier lead times or maintain a deliberate safety margin remains vulnerable to stock-out whenever a delivery is delayed or demand spikes unexpectedly, irrespective of how faithfully its day-to-day stock movements are recorded. The finding that losses and adjustments were the only component showing no significant state-level variation, while five of the remaining six components did vary significantly, is notable in this respect: it suggests that the recording of what has already occurred (losses, adjustments) is comparatively insulated from local institutional or infrastructural context, whereas the practices oriented towards anticipating what has yet to occur (lead times, thresholds, shipment scheduling, safety stock) are considerably more sensitive to it.

The pronounced Rivers–Cross River divide observed across several components warrants particular comment. Rivers State, as the commercial and administrative hub of the South-South region, hosts a denser concentration of pharmaceutical wholesalers, a more developed private distribution infrastructure, and greater exposure to donor-supported health commodity programmes than the more rurally dispersed practice settings sampled in Cross River State [9,10]. It is plausible that this differential infrastructural exposure, rather than any difference in the underlying training or qualification profile of respondents, accounts for the observed disparity in the more anticipatory inventory-control practices; this interpretation is consistent with the absence of any significant variation by sector of employment or area of practice, both of which are proxies more closely tied to individual institutional type than to regional infrastructure. If this interpretation holds, then interventions aimed at strengthening advanced inventory-control practice in the region would be more effectively targeted at the level of regional supply infrastructure — warehousing capacity, wholesaler density, and donor programme reach — than at the level of individual facility training alone, although the latter remains a necessary complement.

The observation that computerised stock-keeping was three times more prevalent in Rivers and Bayelsa States than in Akwa-Ibom and Cross River States echoes a broader concern, already registered in the parent study, regarding the limited penetration of computerised inventory systems in Nigerian pharmaceutical practice settings [4]. Comparable studies from elsewhere in the region have similarly noted that manual stock cards remain the dominant recording medium even where more developed logistics management information systems exist in principle [11,12]. The present findings extend this observation by showing that the disparity in computerisation is itself geographically patterned rather than uniform, which is consistent with the broader argument that infrastructural rather than purely behavioural factors underlie much of the observed variation in inventory-control practice.

Some limitations should be borne in mind in interpreting these findings. The data derive from self-report on a structured questionnaire administered in 2015, and are therefore subject to the customary limitations of self-reported practice data, including social desirability bias and the possibility that some respondents interpreted the frequency categories (“Always”, “Sometimes”, “Never”) differently. The cross-sectional design does not permit inference of causal direction between geography and inventory practice, and the modest cell sizes within some of the state-by-component cross-tabulations, particularly for Akwa-Ibom and Cross River States (n=25 each), warrant caution in generalising the magnitude, if not the direction, of the observed associations. Notwithstanding these limitations, the internal consistency of the geographic pattern across five independent inventory-control components strengthens confidence that the observed state-level variation reflects a genuine underlying phenomenon rather than a chance artefact of a single measurement.

V. CONCLUSION

Health professionals in this study demonstrated a clear hierarchy of engagement with the components of inventory control, monitoring what is immediately observable — current stock levels and consumption — considerably more consistently than the anticipatory components of lead times, stock thresholds, shipment scheduling and safety-stock provision that are central to averting stock-outs. This deficit was patterned by state rather than by sector of employment or area of practice, pointing towards regional supply infrastructure, rather than individual facility type, as the more probable driver of variation. Efforts to strengthen pharmaceutical inventory management in the region should accordingly look beyond facility-level training in stock recording towards the regional logistics infrastructure — wholesaler and distributor density, donor programme reach, and access to computerised logistics management information systems — that appears to condition how fully the anticipatory functions of inventory control are practised.

CONTRIBUTION TO KNOWLEDGE

This study extends the existing literature on pharmaceutical supply chain management in Nigeria by moving beyond the conventional, and comparatively coarse, characterisation of inventory management as a question of recording medium alone (stock card, ledger or computer). It is the first analysis, to the authors' knowledge, to disaggregate and empirically compare the six anticipatory components of the logistics cycle — consumption monitoring, loss and adjustment documentation, supplier lead-time tracking, maximum/minimum stock-level maintenance, shipment and handling scheduling, and safety-stock provision — among pharmaceutical supply chain personnel in South-South Nigeria. In doing so, it demonstrates that inventory-control practice is not a uniform construct but a hierarchy, with facilities considerably more consistent in tracking what is immediately observable than in the anticipatory functions that guard against stock-out. It further establishes that this hierarchy is patterned by state rather than by sector of employment or area of practice, a distinction with direct implications for how future interventions to strengthen pharmaceutical logistics in the region should be designed and targeted — towards regional supply infrastructure rather than facility-level training alone.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest, financial or otherwise, in relation to the conduct of this study or the preparation of this manuscript.

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