



Development of preventive strategies to optimise the logistical management of medical device stocks in Likasi (DRC)

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ABSTRACT

Introduction: Stock-outs of medical devices pose a major challenge to the performance of health systems in resource-limited countries. In Likasi (DRC), these stock-outs compromise the continuity and quality of care, necessitating

an in-depth analysis of their determinants and appropriate preventive strategies.

Methods: A cross-sectional study with an analytical focus was conducted among 60 participants, including stock managers, pharmacists and healthcare staff. Data were collected using structured questionnaires. A quantitative analysis (univariate, bivariate and multivariate) was

supplemented by a qualitative analysis based on the Tropes software model.

Results: The majority of organisations had experienced stock-outs over the past twelve months. The main determinants identified were poor demand forecasting, inadequate planning, a lack of funding and low levels of digitalisation within the logistics system. Organisation relies predominantly on manual tools, limiting the effectiveness of monitoring and decision-making. Stock-outs have significant impacts on the quality of care, including delays in treatment, postponements of procedures and frequent recourse to external purchases by patients.

Discussion: The results confirm that stock-outs are primarily linked to internal failings within the logistics system rather than external constraints. The proposed strategies include digitalisation, staff training, improved planning and enhanced coordination.

Keywords: Stock-outs; Medical devices; Hospital logistics; Supply chain; Quality of care.

1. Introduction

Globally, the logistical management of stocks of medical devices and equipment is an essential pillar of the functioning of health systems. However, many countries, particularly low- and middle-income countries, face frequent stock-outs that compromise access to essential care. According to the World Health Organisation, around 30 per cent of healthcare facilities in these settings experience recurrent stock-outs of essential medical supplies, which directly affects the continuity of care and patient safety (WHO, 2021). These stock-outs are often linked to shortcomings in demand forecasting, poor integration of logistics information systems and disruptions to the global supply chain, exacerbated by health crises such as COVID-19 (WHO, 2022).

In Africa, the challenges associated with medical stock management are even more pronounced due to structural, economic and logistical constraints. Around 30–40 per cent of African healthcare facilities face frequent shortages of medicines and medical devices, reflecting a chronic weakness in supply systems (Mwangi et al., 2019; WHO, 2021). The main causes include the fragmentation of logistics networks, inadequate transport infrastructure, dependence on imports and a lack of effective information systems (Nkongho et al., 2023; Devex, 2025). Furthermore, the shortage of qualified human resources in health logistics and the lack of transparency in data exacerbate the difficulty in anticipating needs and preventing stock-outs (OO2, 2026).

In the Democratic Republic of the Congo, the challenges of managing the logistics of medical device stocks are exacerbated by systemic factors such as inadequate funding of the health system, organisational shortcomings and infrastructural constraints. Nearly 50 per cent of hospitals experience regular shortages of essential medicines, revealing a significant inefficiency in the supply system (Ministry of Health, 2021). Logistical difficulties are also exacerbated by the poor state of road infrastructure, insecurity in certain areas and challenges related to the transport of medical supplies, as observed during the response to the Ebola epidemic, where logistics were a critical component of the health intervention (WHO, 2020). Furthermore, the lack of effective computerised systems and poor stock management contribute to both stock-outs and overstocking (Muleka & Ngoy, 2020).

In the Greater Katanga region, characterised by extensive mining activity and increased pressure on health services, the logistical management of medical supplies remains problematic. Healthcare facilities there face frequent stock-outs due to high demand, prolonged supply lead times and a reliance on import channels. Logistical constraints linked to the remoteness of certain areas and inadequate transport infrastructure further complicate the delivery of medical supplies. Furthermore, poor coordination between stakeholders in the health system and the lack of effective stock monitoring mechanisms limit the overall performance of logistics management (WHO, 2022; Africa CDC, 2024).

At the local level, particularly in the town of Likasi (Haut-Katanga province), the issue of stock-outs of medical devices is of particular concern. Healthcare facilities there are faced with stock management that is still largely manual, poor forecasting capacity and a lack of training for staff in healthcare logistics. Studies conducted in the Congolese context show that up to 35 per cent of medical products may be lost due to expiry as a result of poor supply management, whilst stock-outs remain frequent (Kanku et al., 2022). These shortcomings reflect a lack of effective logistics management and limited use of digital tools, which restricts healthcare facilities' ability to anticipate needs and ensure the continuous availability of medical devices (Doctors Explain Digital Health, 2025).

The overall analysis shows that stock-outs of medical devices constitute a systemic problem, present at all levels but particularly acute in developing countries and in Africa. In the DRC and in Greater Katanga, these challenges are exacerbated by structural, logistical and organisational constraints. In Likasi, the situation reflects these trends, with an urgent need to strengthen logistics management, notably

through digitalisation, training and improved stock governance.

The continuous availability of medical devices and equipment is a major challenge for the performance of health systems, particularly in resource-constrained countries. Indeed, inefficient stock management leads to frequent stock-outs, compromising the quality of care and increasing preventable mortality (World Health Organisation [WHO], 2021). Globally, health systems face growing challenges linked to the complexity of supply chains, fluctuations in demand and financial constraints, making the optimisation of logistics management essential (Lee et al., 2020).

In Africa, health systems are particularly vulnerable due to structural shortcomings, notably the absence of computerised stock management systems, weak logistics infrastructure and a shortage of staff qualified in logistics management (Mutale et al., 2018). These shortcomings lead to frequent stock-outs of medical devices, thereby limiting access to essential care. Furthermore, dependence on imports and long lead times exacerbate these problems (Yadav et al., 2020).

In the Democratic Republic of the Congo, the situation is even more worrying due to systemic constraints such as underfunding of the health sector, instability in supply chains and poor coordination between logistics stakeholders (Ministry of Health of the DRC, 2021). In many healthcare facilities, stock-outs are frequent and losses due to expiry or poor management remain high, reflecting weak logistics management (Mputu et al., 2022).

In Haut-Katanga province, and particularly in Likasi, these challenges are exacerbated by population pressure, mining activity and rising demand for healthcare services. Local healthcare facilities face recurring shortages of medical supplies, due in particular to inadequate planning, a lack of rigorous stock monitoring and a lack of preventive strategies tailored to the local context (Kabongo et al., 2023). Consequently, the development of preventative strategies appears essential to improve the effectiveness of logistics management and ensure the availability of medical supplies.

Despite the strategic importance of medical devices in the delivery of care, healthcare facilities in Likasi continue to face frequent stock-outs. These stock-outs reflect a failure in logistics management, characterised by poor planning, inefficient supply management and inadequate logistics information systems (WHO, 2021).

Furthermore, modern management tools such as computerised logistics management systems remain underutilised in these

facilities, limiting the ability to anticipate needs and prevent stock-outs (Yadav et al., 2020). This situation is exacerbated by a lack of coordination between the central, provincial and operational levels of the health system, as well as by inadequate training of staff in logistics management (DRC Ministry of Health, 2021).

In light of these shortcomings, it appears that current strategies are failing to ensure the effective and sustainable management of medical device stocks. Consequently, the central issue addressed in this study is the persistence of stock-outs despite the existence of organisational and logistical mechanisms.

1.1. Central research question

How can effective preventive strategies be developed to optimise the logistical management of medical device stocks in healthcare facilities in Likasi?

1.2. Specific questions

- What are the key factors contributing to stock-outs of medical devices in healthcare facilities in Likasi?
- What organisational and logistical shortcomings are associated with stock management in these facilities?
- What preventive strategies can be implemented to improve the availability of medical devices and reduce stock-outs?

1.3. General hypothesis

Optimising the logistical management of medical device stocks in healthcare facilities in Likasi depends on the implementation of preventative strategies incorporating better planning, the use of effective information systems and capacity building for logistics staff.

1.4. Specific hypotheses

- Stock-outs of medical devices in healthcare facilities in Likasi are significantly linked to poor demand planning and inaccurate consumption forecasting.
- Organisational shortcomings, notably the absence of computerised stock management systems and a lack of coordination between stakeholders, have a negative impact on the availability of medical devices.
- The implementation of preventive strategies such as the digitisation of the stock management system,

staff training and the improvement of supply chains would significantly reduce stock-outs.

1.5. Overall objective

To optimise the logistical management of medical device stocks in healthcare facilities in Likasi by developing appropriate preventive strategies to identify and reduce stock-outs.

1.6. Specific objectives

1. To identify the key factors contributing to stock-outs of medical devices in healthcare facilities in Likasi by analysing organisational, logistical and financial aspects.
2. To analyse the shortcomings of the logistics management system for stock levels, particularly in terms of planning, procurement, information management and coordination between stakeholders.
3. Propose preventive strategies tailored to the local context, aimed at improving the availability of medical devices and sustainably reducing stock-outs.

2. Materials (Study Setting) and Methods

2.1. Study Setting (Setting)

The study is being conducted in the city of Likasi, located in Haut-Katanga province in the Democratic Republic of the Congo. Likasi is an urban area with significant mining activity, characterised by rapid population growth and increased demand for healthcare services. Healthcare facilities in this area include general referral hospitals, public and private health centres, and specialist clinics, providing primary, secondary and tertiary healthcare (Ministry of Health, DRC, 2021).

These healthcare facilities form the institutional framework for the management of medical device stocks. They face significant logistical constraints, including shortcomings in infrastructure, qualified human resources and effective information systems. According to the World Health Organisation, health systems in low- and middle-income countries often suffer from supply chain failures, leading to frequent stock-outs (World Health Organisation [WHO], 2021).

The materials used in this study include data collection tools such as structured questionnaires, semi-structured interview guides and observation sheets. Secondary data from stock records, logistics reports and administrative documents are

also utilised to triangulate the information and strengthen the validity of the results (Creswell, 2018).

2.2. Type and timeframe of the study

This study adopts a descriptive and analytical approach, using a mixed-methods methodology that combines quantitative and qualitative data. This type of approach enables an in-depth analysis of the complex phenomena associated with logistics stock management and identifies the factors underlying stock-outs (Tashakkori & Teddlie, 2010).

The study is cross-sectional and spans a period of six (6) months, enabling the collection of data representative of logistics practices in healthcare facilities in Likasi at a given point in time.

2.3. Population and sampling

The target population for this study comprises all stakeholders involved in the management of medical device stocks in healthcare facilities in Likasi, notably:

- Stock managers;
- Pharmacists;
- Administrative staff;
- Healthcare staff involved in logistics.

The sampling technique used is purposive sampling, which allows for the selection of individuals directly involved in logistics management. This method is commonly used in qualitative and mixed-methods studies to target participants relevant to the research objective (Patton, 2015).

The sample size is determined on the basis of data saturation for the qualitative part, and using statistical criteria for the quantitative part.

2.4. Data collection techniques and tools

Data collection is based on three main techniques:

2.4.1. Structured questionnaire

A questionnaire is administered to the relevant stakeholders in order to collect quantitative data on:

- The frequency of stock-outs;
- Management practices;

- Supply systems;
- Logistical constraints.

Structured questionnaires help to standardise responses and facilitate statistical analysis (Bryman, 2016).

2.4.2. Semi-structured interviews

Interviews are conducted with managers of healthcare facilities to gain an in-depth understanding of logistical management mechanisms and the causes of stock-outs. This technique enables the collection of rich, contextualised qualitative information (Kvale & Brinkmann, 2015).

2.4.3. Document analysis

The analysis of documents (stock registers, logistics reports, procurement records) enables us to verify the consistency of the information collected and to identify discrepancies between reported data and actual practices (Bowen, 2009).

2.5. Study variables

The variables studied are classified into two categories:

2.5.1. Dependent variable

- Frequency of stock-outs of medical devices.

2.5.2. Independent variables

- Requirements planning.
- Procurement system.
- Inventory management.
- Logistics information system.
- Staff training.
- Logistics governance.

The definition of these variables is based on supply chain management models and systemic approaches to health logistics (Mentzer et al., 2001).

2.6. Data analysis methods

Quantitative data are analysed using descriptive statistics (frequencies, percentages, means) and inferential statistics (chi-squared test) to identify relationships between variables.

Qualitative data are analysed using a thematic approach, enabling the identification of the main themes related to malfunctions in the logistics system. This method involves coding, categorising and interpreting data from interviews and documents (Braun & Clarke, 2006).

The integration of quantitative and qualitative data enables methodological triangulation, thereby strengthening the validity and reliability of the results (Fetters et al., 2013).

2.7. Ethical considerations

This study adheres to the ethical principles of health research, in particular:

- The free and informed consent of participants.
- The confidentiality and anonymity of data.
- Non-maleficence.

Participants are informed of the study's objectives and have the option to withdraw at any time. These principles are in line with international guidelines on biomedical research (CIOMS, 2016).

3. Presentation of results

3.1. Univariate analysis

Table 1: Characteristics of organisations and respondents.

Variable	Categories	n (%)
Type of facility	Health centre	11 (36.7)
	Private clinic	9 (30)
	Private hospital	6 (20)
	Public hospital	4 (13.3)
Role	Stock manager	10 (33)
	Administrator	9 (30)
	Head Nurse	6 (20)

	Pharmacist	5 (17)
Length of service	> 5 years	13 (43.3)
	1–5 years	11 (36.7)
	< 1 year	6 (20)

Analysis and comments:

- **Health centres** are strongly represented (**36.7 per cent**), which reflects the reality of the healthcare system in Likasi.
- **Stock managers and administrators predominate**, confirming the relevance of the responses regarding logistics.
- **Significant experience (>5 years = 43.3%)** suggests that the information is reliable.

Table 2: Organisation of the logistics system.

Indicator	Details	n (%)
Management system	Manual	19 (63.3)
	Computerised	8 (26.7)
	None	3 (10)
Tools available	Stock records	12 (40)
	Register	10 (33.3)
	Software	5 (16.7)
FIFO	Always/Often	20 (66.7)
	Rarely/Never	10 (33.3)
Min-max thresholds	Yes	16 (53.3)

	No	14 (46.7)
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In-depth analysis:

- **Predominance of manual systems (63.3%)** → a major factor contributing to vulnerability.
- Low level of **digitalisation (16.7%)** → limits traceability.
- **33.3% do not apply FIFO correctly**, increasing the risk of stock-outs or products passing their use-by date.
- Nearly half of organisations **have no defined thresholds** → lack of planning.

Table 3: Frequency and causes of stock-outs.

Variable	Details	n (%)
Discontinuation (12 months)	Yes	23 (76.7)
Frequency	Occasional	12 (40)
	Monthly	10 (33.3)
Out-of-stock products	Medical devices	11 (36.7)
Causes	Poor forecasting	11 (36.7)
	Lack of funding	8 (26.7)
	Supplier delays	6 (20)

Analysis:

- **High prevalence of stock-outs (76.7%)** → major structural problem.
- **Poor forecasting is the main cause**, confirming a weakness in management.
- **Medical devices (36.7 per cent)** are the most affected → consistent with our topic.

Table 4: Procurement and monitoring.

Indicator	Details	n (%)
Supply lead time	< 2 weeks	18 (60)
Planning	Occasional	14 (46.7)
Supplier monitoring	Yes	16 (53.3)
Software use	No	25 (83.7)
Data analysis	Monthly	14 (46.7)

Analysis:

- The lead times are relatively short → **the problem is not solely external.**
- **Inadequate planning (46.7 per cent)** → a key factor in stock-outs.
- Very low level of **digitalisation (83.7% without software)** → limits decision-making.

Table 5: Clinical impact (Clinical staff).

Indicator	Details	n (%)
Disruption experienced	Yes	22 (73.3)
Main impact	Delay in treatment	14 (46.7)
Perceived frequency	Frequent	12 (40)
Impact on quality of care	Yes, significantly	14 (46.7)
External purchase	Sometimes/Often	20 (66.7)

Analysis:

- Stock-outs have a **direct impact on the quality of care (86.7%)**.

- **Delays in treatment (46.7%)** are the main consequence.
- Patients compensate by **purchasing supplies elsewhere (66.7%)** → inequalities in access.

3.2. Bivariate analysis**Table 6:** Association between organisation and stock-outs.

Explanatory variable	Dependent variable	Test	Interpretation
Manual vs computerised system	Stock-out	Chi-squared	Probable association
Absence of min-max threshold	Stock-out	Chi-squared	Strong relationship
Lack of planning	Frequency of disruption	Chi-squared	Significant relationship
Non-use of software	Frequent stock-outs	Chi-squared	Strong association

In-depth analysis:

- **Non-digitised** organisations are more prone to disruptions.
- The absence of **thresholds and planning** is a major determining factor.
- The **Chi² test is appropriate** (qualitative variables).

Table 7: Logistic factors vs clinical impact.

Factor	Impact on care	Interpretation
Frequent rupture	Delay in treatment	Direct relationship
Lack of funding	External procurement	Strong association
Poor forecasting	Product substitution	Indirect impact

Analysis:

- Stock-outs directly affect:
 - **The continuity of care.**
 - **Patient safety.**
- Confirms the link between **logistics and quality of care.**

3.3. Multivariate analysis

3.3.1. Proposed model: Logistic regression

Dependent variable:

- Stock-out (Yes/No)

Independent variables:

- System type (manual/computerised).
- Planning.
- Min-max thresholds.
- Digitisation.
- Data analysis.

Table 8: Explanatory model of disruptions.

Variable	Expected effect	Interpretation
Manual system	↑ Risk	Aggravating factor
No thresholds	↑↑ Risk	Major determinant
Lack of planning	↑↑ Risk	Critical factor
Lack of digitalisation	↑ Risk	Significant impact
Irregular analysis	↑ Risk	Indirect effect

In-depth analysis:

- The **key determinants** are:

1. Lack of planning.
2. Poor forecasting.
3. Low level of digitalisation.

- These factors act in **combination (synergistic effect).**

3.4. Summary by objective

3.4.1. Objective 1: Determinants of disruptions

- ✓ Poor forecasting.
- ✓ Lack of funding.
- ✓ Inadequate organisation.
- ✓ Low level of digitalisation.

Conclusion: supply chain disruptions are caused by **multiple** factors, predominantly internal ones.

3.4.2. Objective 2: Logistical inefficiencies

- ✓ Lack of planning.
- ✓ Failure to use software.
- ✓ Poor coordination.
- ✓ Insufficient data analysis.

Conclusion: the system is **reactive rather than proactive.**

3.4.3. Objective 3: Preventive strategies

Based on the results:

- Digitalisation (priority).
- Staff training.
- Implementation of minimum and maximum thresholds.
- Systematic planning.
- Increased funding.

The analysis shows that stock-outs in Likasi are mainly due to:

- A weak logistics management system.
- A lack of planning and forecasting.
- Low levels of digitalisation.

Solutions must be **structural and systemic**, combining:

- Digital tools.
- Capacity building.
- Improved logistics governance.

3.5. Thematic analysis with verbatims

3.5.1. Theme 1: Weaknesses in logistics organisation

Category: Organisation / Internal management

Keywords: disorganisation, lack of a system, manual management, lack of monitoring.

Verbatim quotes:

"We're still working with notebooks; there's no reliable system for tracking stock."

"Stock records aren't always updated, which leads to significant discrepancies."

"There's no coordination between departments when it comes to managing products."

Analysis:

- The system is largely manual, which leads to:
 - Human error.
 - Loss of information.
- Lack of standardisation → empirical management.
- Direct correlation with quantitative results (63.3% manual).

Interpretation Tropes: Dominant universe = structural disorganisation.

3.5.2. Theme 2: Failure of planning and forecasting

Trope's category: Anticipation / Forecasting

Keywords: lack of foresight, lack of planning, late orders

Verbatim quotes:

"Orders are placed when stock is already almost finished."

"There are no forecasts based on actual consumption."

"We react to stock-outs rather than preventing them."

Analysis:

- Reactive rather than proactive approach.
- Lack of thresholds → stock-outs can be anticipated but not prevented.
- Confirms poor forecasting (36.7 per cent).

Interpretation Tropes: Environment = constant crisis management.

3.5.3. Theme 3: Financial constraints and suppliers

Trope's category: Resources / External constraints

Keywords: funding, delay, dependence, insufficiency

Verbatim quotes:

"The allocated budget is not sufficient to cover our needs."

"Suppliers often deliver late, which exacerbates stock-outs."

"We are dependent on partners, which limits our autonomy."

Analysis:

- Important but not exclusive external factors.
- Interaction with internal factors (planning).

Interpretation Tropes: Context = structural dependence.

3.5.4. Theme 4: Low level of digitalisation of the system

Trope's category: Technology / Innovation

Keywords: lack of software, lack of digitalisation, untapped data

Verbatim quotes:

"We don't use any software for stock management."

"The data exists but it isn't analysed."

"Digitisation could really improve our system."

Analysis:

- Strong correlation with:
 - Poor forecasting.
 - Lack of monitoring.
- Only 16.7 per cent use software.

Interpretation of Tropes: Universe = technological lag.

3.5.5. Theme 5: Impact of disruptions on the quality of care

Trope's category: Consequences / Health

Keywords: delay, transfer, risk, quality of care

Verbatim quotes:

"Patients have to wait a long time because of supply shortages."

"Some procedures are postponed due to a lack of equipment."

"We are sometimes forced to transfer patients."

Analysis:

- Direct impact:
 - Continuity of care.
 - Patient safety.
- Consistency with:
 - Treatment delays (46.7 per cent).
 - Compromised quality (86.7%).

Interpretation of tropes: Context = deterioration of the healthcare system.

3.5.6. Theme 6: Proposed strategies

Trope's category: Solutions / Improvement

Keywords: training, digitalisation, coordination, funding

Direct quotes:

"Staff need to be trained in stock management."

"Introducing software would improve traceability."

"Better coordination between departments is needed."

Analysis:

- Solutions aligned with the identified causes.
- High demand for:
 - Digitalisation.
 - Capacity building.

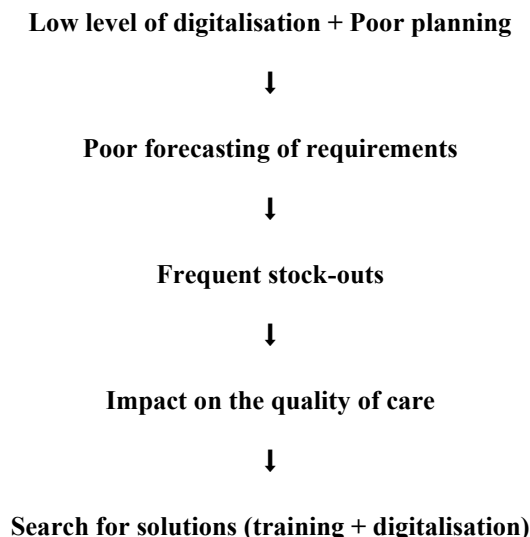
Interpretation Tropes: Universe = transition to a modernised system.

3.6. Summary of reference universes (tropes)

Dominant universe	Description
Disorganisation	Manual and unstructured system
Reactivity	Lack of foresight
Dependence	Financial and supplier constraints
Technological lag	Low level of digitalisation
Impact on health	Deterioration in the quality of care
Transformation	Need for modernisation

3.7. Modelling of relationships (tropes logic)

Interpretative diagram:



The qualitative analysis reveals that:

- Disruptions are perceived as **avoidable but poorly anticipated**.
- The system is dominated by **empirical and manual management**.
- The consequences are **felt directly by patients**.
- Stakeholders are aware of the solutions but face:
 - Structural constraints.
 - A lack of resources.

4. Discussion of results

The findings regarding the identification of the determinants of stock-outs show that these are part of a multifactorial dynamic dominated by inadequate forecasting, financial constraints and internal organisational failings. The high proportion of organisations that have experienced stock-outs over the last twelve months points to a structural dysfunction in the local logistics system. The qualitative analysis highlights a management approach that remains largely empirical, characterised by a lack of foresight and increased dependence on suppliers. These observations are consistent with the work of Yadav, which demonstrates that in resource-constrained settings, stock-outs are primarily attributable to poor planning and management capacity rather than to a general unavailability of products (Yadav, 2015). Similarly, the World Health Organisation emphasises that organisational

failures and poor demand forecasting are major causes of stock-outs in the health systems of developing countries (World Health Organisation, 2017).

An analysis of the shortcomings in the logistics management system reveals a predominance of manual practices and limited integration of digital technologies, thereby restricting the capacity of organisations to ensure rigorous monitoring and efficient stock management. Irregular order planning and the limited use of consumption data reflect a system that is reactive rather than proactive. These findings are consistent with the conclusions of USAID's DELIVER project, which highlights the central role of logistics information systems and coordination in supply chain performance (USAID, 2011). Furthermore, UNICEF emphasises that the continued use of manual systems in resource-constrained countries contributes to management errors, loss of information and delays in decision-making (UNICEF, 2020). The paradox observed between relatively short lead times and the high frequency of stock-outs confirms that the difficulties stem more from internal organisation than from the external environment.

The findings regarding the impact of supply shortages on the quality of care highlight significant consequences for patient management, particularly in terms of delays in treatment, postponements of procedures and the use of alternatives that are sometimes inappropriate. The high frequency of these situations, combined with the need for patients to source certain products from outside the healthcare system, reflects a deterioration in the accessibility and continuity of care. These observations confirm the findings of Mikkelsen-Lopez, which demonstrate that shortcomings in stock management and logistics information systems have a direct impact on the availability of essential products and the quality of healthcare services (Mikkelsen-Lopez et al., 2014). Thus, stock-outs appear not only as a logistical problem, but also as a critical determinant of the overall performance of the health system.

Finally, the strategies proposed to prevent stock-outs centre on staff training, the digitisation of management systems, improved coordination and the strengthening of financial resources. These approaches are in line with international recommendations, notably those of the World Bank, which identifies human capacity building and the modernisation of information systems as key drivers for improving the performance of healthcare supply chains (World Bank, 2018). Furthermore, Barrington's research highlights the effectiveness of digital solutions in reducing stock-outs and improving the availability of healthcare products (Barrington et al., 2010). In this context, the implementation of these strategies requires an integrated approach underpinned by strong institutional commitment, in order to ensure a

sustainable improvement in logistics management and the quality of care within Likasi's healthcare facilities.

5. General conclusion

This study highlights that stock-outs of medical devices in healthcare facilities in Likasi constitute a recurring and systemic problem, the causes of which are primarily internal to the logistics management system. A combined analysis of quantitative and qualitative data shows that these stock-outs result mainly from inadequate planning, poor demand forecasting, a poorly structured logistics organisation and a low level of digitalisation. Although external constraints such as limited funding and supplier delay also contribute to this problem, they appear to be secondary to internal organisational failings.

Furthermore, the study highlights that these stock-outs have direct and significant consequences for the quality of care, notably through delays in treatment, the postponement of procedures and increased reliance on external purchases by patients. These effects compromise not only the continuity of care, but also equitable access to healthcare services. Stock-outs should therefore not be viewed solely as a logistical problem, but as a major public health issue and a challenge to the performance of the healthcare system.

Finally, the findings highlight that practitioners on the ground are fully aware of the system's weaknesses and propose relevant solutions, centred on training, digitalisation and improved coordination. This indicates that there is significant potential for improvement, provided that structural measures are implemented in a consistent and sustainable manner.

6. Policy recommendations

In light of the findings, several strategic recommendations can be made for the attention of decision-makers and healthcare system managers:

6.1. Strengthening logistics governance

It is essential to establish a clear and structured institutional framework for the management of medical device stocks, including national standards for planning, monitoring and evaluation. Empowering stakeholders and establishing accountability mechanisms will improve the transparency and efficiency of the system.

6.2. Digitisation of the stock management system

Modernising the logistics system through the introduction of digital tools (such as DHIS2 or mSupply) is a priority.

Digitalisation will improve stock traceability, data quality and real-time decision-making, whilst reducing errors associated with manual systems.

6.3. Staff capacity building

It is essential to develop ongoing training programmes in the logistics management of healthcare products, including forecasting techniques, supply management and data analysis. Skills development will help to professionalise stock management and improve the system's performance.

6.4. Improving planning and forecasting

Healthcare facilities must adopt standardised tools and methods for quantifying requirements, based on actual consumption data and epidemiological trends. The introduction of minimum and maximum thresholds will enable organisations to anticipate stock-outs and ensure the continuous availability of products.

6.5. Optimisation of the supply chain

Monitoring of supplier performance should be strengthened and supply sources diversified in order to reduce the risks associated with delivery delays. Better coordination between the various stakeholders (healthcare facilities, health authorities, technical and financial partners) is also necessary.

6.6. Increasing and securing funding

Adequate and sustainable funding must be guaranteed for the supply of medical devices. It is recommended that specific budget lines be established and that mechanisms for mobilising resources be strengthened, whilst ensuring transparent management of funds.

6.7. Establishment of a monitoring and evaluation system

Finally, the introduction of an effective monitoring and evaluation system, based on key logistics performance indicators (stock-out rates, lead times, availability rates), will ensure effective management and continuous improvement of the system.

Implementing these recommendations requires an integrated, multi-sectoral approach involving all stakeholders in the health system. It represents a strategic opportunity to strengthen the resilience of the health system in Likasi and, more broadly, in similar contexts across the Democratic Republic of the Congo.

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Declaration of conflicts of interest

The authors declare that there are no conflicts of interest relating to this study. They certify that this research was conducted with complete scientific independence, without any external influence likely to affect the results or their interpretation.

Ethical considerations

This study was carried out in accordance with the ethical principles applicable to health research, in particular those relating to respect for human dignity, confidentiality and the anonymity of the data collected. Participants were informed of the study's objectives, their right to refuse to take part or to withdraw at any time without prejudice, and the conditions under which their data would be processed. Free and informed consent was obtained from each participant prior to data collection. The information gathered was treated confidentially and used exclusively for scientific purposes.

Authors' contributions

All authors made a significant contribution to the conduct of this study. The design of the research protocol and the definition of the objectives were carried out jointly by the authors. Data collection was carried out in the field with the active participation of several authors. The analysis of quantitative and qualitative data was carried out collaboratively. The manuscript was drafted by all the authors, with critical reviews and successive revisions. All authors have read and approved the final version of the manuscript.

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