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Does pharmaceutical information systems data inform decision-making in public healthcare? Utility of a national system in a limited resource setting

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ABSTRACT

Background: Globally, weak pharmaceutical information systems (PIS) negatively affect universal health coverage and outcomes. Few studies in sub-Saharan Africa qualitatively and quantitatively assess drivers and utility of data from PIS in public healthcare.

Methods: A nationwide cross-sectional descriptive study interviewed PIS focal persons in all 14 regions of Namibia. The primary outcome was extent and predictors of utility of PIS data. The extent of utility of PIS data was determined using descriptive statistics and predictors by logistic regression in SPSSv24 or thematic analysis for qualitative data.

Results: The study recruited 58 key informants at facility-based 56 (96.6%) and national 2 (3.4%) levels. Of the 56 facility-based respondents, 29 (51.8%) were female and 27 (48.2%) pharmacists. The mean age and PIS work experience were 33.5 ± 7.6years and 4.5 ± 3.3years respectively. The utility level of PIS data was 34 (60.7%) (target >80%). A total of 103 uses of PIS data were cited; of which 38 (36.9%) were informing decisions on rational medicine use, 27 (26.2%) on pharmaceutical stock management and 24 (23.3%) on strengthening pharmacy workforce. The utility of PIS data significantly decreased with lack of systems on routine reporting by health facility in-charge (cOR = 0.25, 95%CI: 0.06,0.90, $p = 0.035$). Longer work experience (cOR = 1.05, 95% CI: 0.88,1.25, $p = 0.58$), formal consultations (cOR = 1.29, 95%CI: 0.14,11.54, $p = 0.82$), and availability of feedback systems (cOR = 1.08, 95%CI: 0.33,3.56, $p = 0.89$) appeared to increase utility of PIS data. Two thematic drivers of utility of PIS data were programmatic *"feedback and action on PIS; structures, technical support for PIS discussion"*; technical *"training/technical capacity of staff; tools and resources for data collection and utilization"*; and human-resource *"staff availability and workload; attitude and commitment"*.

Conclusion: The nationwide study shows sub-optimal utility of PIS data in public healthcare in Namibia, which negatively affects delivery of pharmaceutical services. This calls for action to enhance capabilities for utilization of automated real-time pharmaceutical information decision support systems to enhance real-time analysis and feedback on medicines data in resource-limited settings.

Introduction

Pharmaceutical public health indicators remain suboptimal in most low-and-middle-income-countries (LMICs) with the highest burden of diseases such as HIV/AIDS.[1] Poor indicators are partly attributed to limited utility of pharmaceutical health information.[2–5] The poor indicators point to irrational medicine use that is costly and a threat to antimicrobial resistance.[6–8]

Globally, health management information systems (HMIS) have been integrated in public healthcare to monitor and enhance quality service delivery and outcomes.[9–12] Pharmaceutical services and commodities are a critical pillar of public healthcare.[13] HMIS provides valuable information for decisions, policies, and interventions to improve healthcare. Pharmaceutical information system (PIS) is part of HMIS, generating medicines information in healthcare.[14,15] For example, PIS is used in high income countries like Sweden to assess adherence to an agreed prescribing guidance.[16] World Health Organization/International Network for Rational Use of Drugs (WHO/INRUD) indicators are widely used to assess prescribing and use of medicines, but the indicators give limited information on quality of prescribing of

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medicines.[17,18] Implementation of PIS that utilize quality indicators facilitates accurate monitoring and evidence for public health programs to achieve the desired health outcomes at manageable costs.[19,20] However, in most LMICs, such as Namibia, despite the wide-use of PIS indicators,[21] their utility to monitor pharmaceutical services in public healthcare has not been evaluated.

Extent and predictors of utility of pharmaceutical and health information

Studies in many LMICs show variable utility of health information in public healthcare but all point towards building stronger health systems.[22,23] Fairly good utility (>50%) of HMIS and PIS information has been reported in Ethiopia and Namibia.[24–27] South Africa, Pakistan, Rwanda and Ethiopia have registered limited utility of HMIS information.[28–31] Since the implementation of Pharmaceutical Management Information System (PMIS) in 2007 in Namibia, the extent and predictors of utility of PIS information in public healthcare have not been validated. This information gap may negatively impact on managers' evidence-based decisions to improve access to essential medicines and services which leads to limited outcomes of public health interventions. Yet, utility of PIS data can help managers focus efforts on improving quality of care.[32] Utility of PIS indicator data is, thus, considered key in helping managers answer questions on quality of care and guide actions.[33,34]

Human, programmatic, and technical factors influence systems and utility of information.[35,36] The factors may include training, qualified staff, user satisfaction, roles and tasks, structures such as for dissemination of information, workflow, quality, and usability of data.

Although health workers in Namibia's public health facilities report on PIS data regularly[37] since 2007, the extent and predictors of utility of the PIS information and its impact on delivery of pharmaceutical services and outcomes has not been evaluated. This may negatively impact on the timely and equitable access to essential pharmaceutical public health services and commodities leading to suboptimal targets among programs implementing public health interventions, impact on rational use, and management of essential public health medicines and/or commodities.[38]

This study assessed the extent and predictors of utility of PIS data in public healthcare in Namibia. The findings will aid development of an indicator data utility model to guide Ministry of Health and Social Services (MoHSS) managers to plan, implement, and monitor impact on pharmaceutical public health. The study evaluated the null hypothesis that the utility of PIS data/indicators is limited at public health facilities in Namibia.

Materials and methods

Design and population

A nationwide cross-sectional descriptive study was used to interview PIS focal persons at national and public health facility levels in all the 14 regions of Namibia. Two key informants were recruited per each of the 38 health facilities included in the national PIS database 2007–2015 and or national level.

Pharmaceutical information system (PIS) in Namibia

The MoHSS of Namibia implemented a Pharmaceutical Management Information System (PIS) in 2007. The nationwide implementation was a collaborative effort between MoHSS and development partners based on a PMIS manual to guide implementation.[39] The manual provides templates for data collection and analysis, defines indicators to be reported on, and determines the frequency of reporting. In addition, a set of pharmaceutical standard operating procedures (SOPs) are used to guide pharmaceutical service delivery at public healthcare facilities. To ensure appropriate implementation, the MoHSS with support of partners routinely conducts national annual PIS supportive supervision visits (SSVs).[40] The MoHSS also supported in-service trainings in 2007, 2008, 2013, and 2014 to enhance capacity of staff on PIS. It provides routine technical assistance through annual SSVs for onsite mentoring, annual Pharmacists' forum, and answering telephonic queries from facilities. Regional staff do quarterly SSVs for monitoring performance and service delivery and to mentor staff on PMIS.

Pharmacy staff [pharmacists, pharmacist assistants (PAs) and pharmacy technicians (PTs)], and nurses in charge are responsible for pharmaceutical data collection, analysis, quarterly reporting, feedback to colleagues and utility of information. The MoHSS Division Pharmaceutical Services, National Medicines Policy Coordination (NMPC) Senior Pharmacist compiles a national feedback report with recommendations to the regions, districts, facilities as well as two multi-regional medical deports and central medical stores (CMS). Every year, the MoHSS Division Pharmaceutical Services with support of partners holds an annual pharmacists' forum.[41] At the forum, findings and recommendations from annual SSVs and PIS reports are discussed and action plans developed.

Data collection procedure

Quantitative and qualitative data were collected using pre-tested semi-structured questionnaires over a 6-month period, July 2019 to December 2019. Interviews were conducted among key informants on PIS, i.e. designated PIS focal persons at public health facilities and MoHSS managers at district/regional/national levels. The study only included respondents involved in the collection, management, reporting, and use of PIS data at all public health facilities in Namibia. The interviews assessed the extent of PIS reporting, modes of delivery, and timeliness of receipt of feedback on PIS; dissemination of PIS information, management decisions, or action taken based on the indicator status and recommendations; factors influencing utility of PIS information; and suggestions for enhancing utility of the information. The study also assessed implementation of interventions that were aimed at creating awareness and enhancing health worker capacity for reporting on pharmaceutical indicators of public health. Data were kept confidential and analysis excluded personally identifiable information.

Data analysis

Data were double entered in Epidata version3.1 software for management and exported to SPSS version 24 for quantitative analysis. The study aimed to test the hypothesis (H_0) that the utility of PIS data/indicators is limited at public health facilities in Namibia. The primary outcomes were the quantitative and qualitative drivers and the utility of PIS data in public health facilities in Namibia. The secondary outcomes were the association of covariates with utility of PIS data, factors influencing utility, and respondents' recommendations. The extent of utility of PIS data were determined using descriptive statistics, i.e., frequencies. In this study, utility of PIS data was defined based on documented evidence on the use of data to inform decision-making at the health facility/district/regional and national level in the past 12-months. The drivers/predictors of utility, as well as factors associated with utility of PIS data by MoHSS managers and facility-based focal persons were determined quantitatively using bivariate logistic regression analysis using crude odds ratios (cOR). Quantitative data were analyzed by level of health care; collection and reporting on PIS indicators; feedback and utility of PIS data; receipt, compilation, and dissemination of PIS information feedback to health facilities/districts/regions; evidence of utility of PIS data; and factors that influence utility. The level of significance for inferential statistics, alpha, was set at 0.05 for a 95% confidence interval. A PIS data utility level of 100% was deemed ideal, while an 80% utility level was considered as acceptable for this study. In addition, content thematic analysis was done using color coding to identify qualitative themes of drivers of utility of PIS

data. The findings on the qualitative and quantitative drivers of utility of PIS data were triangulated and integrated in the discussion of results.

Ethics

The Human Research Ethics Committee (HREC) of the University of Namibia (UNAM) and the Research and Ethics board of the MoHSS (26 February 2019) approved this study. Only respondents who gave written informed consent after being given detailed information on the study, their rights to/not to participate, and assurance of confidentiality participated in the study. The identities of respondents have been kept confidential with findings reported only in aggregated form with no personally identifiable information.

Results

Characteristics of respondents

Of 78 target key informants, 58 (74%) were recruited from 37 facilities/district/regional level (n = 56) and national level (n = 2). The 56 focal persons from facilities/district/regional level represented 14 (100%) regions and 31 (91%) districts of Namibia. Most of the 56 respondents were female 29 (51.8%), not married 38 (67.9%), and in the age category of 25–29 years (40.7%). In addition, 27 (48.2%) were pharmacists (or had a degree) and 43 (76.8%) had worked in the positions for more than two years (mean duration = 4.5 ± 3.3 years). The mean age of the respondents was 33.5 ± 7.6 years (range: 24–52 years). Of the 56 respondents, 34 (60.7%) had district level responsibility compared to 18 (32.1%) at facility and 4 (7.1%) at region. A total of 37 facilities countrywide were represented (31 hospitals, 2 health centers, 4 clinics).

Level of utility of PIS data in Namibia

Of the 56 facility/district/region based focal persons, 60.7% (n = 34) had utilized PIS data in the past 12 months to inform decisions to improve medicine use and/or delivery of health services. Of the 103 stated uses of PIS data by focal persons, 38 (36.9%) were for decisions on rational use of medicines, particularly antibiotics and generic medicines; 27 (26.2%) for pharmaceutical stock management to reduce wastage, expenditure, and expiries through stock rotation; and 24 (23.3%) towards strengthening pharmacy workforce based on workload indicators to address staff workload (**Table 1**). Further, PIS data were used as motivations for recruitment of pharmacy staff and faster filling of vacant posts so that pharmacy staff were able to serve patients in a shorter time (reduced patients' waiting time) and counsel patients on taking their medicines appropriately. The main qualitative thematic areas for utilization of PIS data are included in Table 1.

Table 1
Qualitative themes on utility of PIS information (n = 103).

Themes	n (%) per theme	Respondents' quotations
Promoting rational use of medicines	38(36.9)[a]	*"A Rational drug use committee was formed after discussion about the prescription pattern of the hospital. The information was taken from the PIS report. The drug and therapeutic committee discussed about the prescription pattern of the hospital and formed Rational drug use committee to monitor the prescriptions, Namelists and standard treatment guidelines were distributed to improve the prescribing pattern"* *"Antibiotic use: Research showed >40% in 2018. After 1–2* months *following research (baseline), follow up/review showed <20%. Intervention was the review meeting and watching prescriptions"* *"During a flu outbreak, all patients were given antibiotics until prescribers were cautioned. Consumption data was used to act on antibiotic use"*
Facilitating pharmaceutical stock management	27(26.2)[a]	*"Reduced expiry & reduced rate of wastage e.g. from ~1.5% to ~0.3%. Improved ordering based on stock management, more active stock rotation within facilities in the region"* *"Wastage rate indicator results have helped to start monitoring pharmaceutical orders (both item and quantity); the ministry has now started putting budget ceiling for pharmaceutical supply for each facility"*
Strengthening pharmacy workforce	24(23.3)[a]	*"At facility level, Q1 and Q2 financial year reports: PIS indicators on workload (average number of prescriptions per dispenser per day) showed increased workload especially in outpatient and inpatient pharmacy units. Pharmacy department had 2 vacant pharmacists' post and one PA post at the staff establishment. A recommendation was put forward to fill these posts immediately to human resource. The posts were filled by start of Q4. A 3% reduction in the same indicator was noted at the end of Q4. Patient waiting times and customer care complaints also generally reduced."* *"Report showed more medicines needed for the increasing patients and workload at clinic level versus health center status, so we got 2 new pharmacy cadres."*

[a] This frequency or percentage was determined using a tally system to account for each statement/example stated in a single quote, because within a single quote many options may have been stated. Each respondent could give up to four examples of use of PMIS/pharmaceutical information hence n > 34 who indicated utility of information.

Drivers of utility of PIS data by at health facilities

PIS focal person's interviews

The majority [32 (58.2%) (n = 55)] of the PIS focal persons had either not received workshop training on PMIS or were unsure; 26 (50.0%; n = 52) were rated as extremely/very good on technical expertise for pharmaceutical data collection, report compilation, feedback, and utility. In-service training, supportive supervision by regional and national level staff, mentoring and on-the-job training, continuous professional development (CPD) and meetings, and self-study, such as using the PMIS manual and pharmacy SOPs, were the listed other forms of training on PIS. Key informants (KIs) also listed the annual pharmacists' forum. Few respondents 23 (45.1%; n = 51) reportedly received PIS feedback at least once in 3 months. KIs confirmed regular/quarterly dissemination of a national PIS feedback report; sometimes, these were not within target timeline but were always followed up through SSVs. Among those who received feedback on PIS information, most found it always clear 31 (58.5%; n = 53) and very/extremely useful 37 (78.7%; n = 47). Feedback was mostly received in formal/written form 34 (85%; n = 40) but rarely within timelines. Almost all 44 (91.6%; n = 48) respondents rated PIS information as extremely/very highly needed.

Only 21 (38.9%; n = 54) managers of facilities represented had ever sought feedback from healthcare workers (HCWs) on PIS; consultations were largely verbal/informal 11 (55%, n = 20), and 17 (50%; n = 34) reportedly utilized pharmaceutical information. This was statistically significant ($p = 0.029$); few 19 (40.4%; n = 47) always disseminated PIS feedback to fellow HCWs, while 7 (14.9%) had never disseminated the information. The timing of dissemination varied from immediate via email, weekly in management/staff meetings, to waiting for the

quarterly therapeutics committee (TC) meeting where these were held quarterly as recommended by the MoHSS. Forums for PIS information dissemination included district and regional TC meetings, District Coordinating Committee (DCC) meetings, management meetings, and economizing committee meetings, especially for pharmaceutical expenditure-related indicators. Participants in PIS information dissemination activities were members of the TC and DCC meetings including health facility managers, pharmacy staffs, medical officers, nurses, and other cadres representing all departments in hospitals/facilities. Most [25 (54.3%; n = 46)] respondents indicated a lack of defined structures for sharing PIS information with region/district/facility staff. PIS information was also discussed in annual pharmacists' forums (KIs).

Predictors of utility of PIS data using binary logistic regression

Except for facility managers consulting HCWs about PIS, which was statistically significant (cOR = 0.25; 95%CI 0.07,0.90; $p = 0.03$), all other covariates shown in Table 2 were not significant ($p > 0.05$). Crude odds ratios showed predictors of utility of PIS information (Table 2).

Demographic factors, age, PIS work experience, and having diploma/certificate education level, appeared to increase the utility of PIS data. Programmatic factors, receiving PIS feedback, facility-level responsibility, facility being a clinic/health center, managers' formal/structured consultation on PIS information, and availability of PIS feedback systems, appeared to increase utility of PIS data. Technical and human resource factors, PIS feedback perceived as extremely useful and highly rated need for PIS information, appeared to increase utility of PIS data.

Factors that appeared to not impact on utility of PIS data included demographic factors: being female, married, or a pharmacist; programmatic factors: PIS workshop training, formal/written mode of receipt of feedback, or regular(quarterly) feedback; technical factors: highly rated technically-competent staff and always clear feedback (Table 2).

Qualitative themes of drivers of utility of PIS information

The qualitative interview on drivers of utility of PIS yielded 204 responses on factors influencing the utility of PIS data. These responses generated three thematic areas on drivers of utility of PIS data, i.e. programmatic drivers 89 (43.6%), technical drivers 77 (37.7%), and human-resource related drivers 38 (18.6%) Table 3.

Of the 89 programmatic drivers, most were related to feedback and action on PIS data 23 (25.8%), existence of structures, forums, and technical support for PIS discussion 22 (24.7%), and resources for interventions on PIS recommendations 20 (22.5%). Among the 77 technical-related drivers were training/technical capacity of staff 41 (53.2%) and existence of tools and resources for data collection, reporting, and utilization 29 (37.7%). Human-resource drivers included mainly staff availability and workload 26 (68.4%). The factors were grouped under themes shown in Table 3.

Strategies to optimize utility of PIS data: recommendations from focal persons

Based on what respondents reportedly experienced that enhanced or hindered utility of PIS information, they recommended enhancing awareness and capacity of staff and managers for PIS management and use; that managers at facility/district/regional and national levels act on recommendations to motivate staff to continue collecting data, reporting, and improving services. Otherwise, monitoring PIS indicators was an unnecessary burden, to an extent. Respondents also desired more timely and useful feedback, dissemination of PIS information for use, and review of PIS indicators.

Table 2
Binary logistic regression for predictors of utility of PIS data in Namibia.

Covariates		Beta coefficient (B)	Wald Chi-Squared Test	cOR (95% CI)	*p*-value
Sex	Female Male	−0.32	0.32	0.73 (0.24, 2.20) 1	0.57
Age	Age	0.02	0.38	1.02 (0.95, 1.11) 1	0.53
Marital status	Married Not married	−0.91	1.88	0.40 (0.11, 1.48) 1	0.17
Cadre	Pharmacist PA/PT (not pharmacist)	−0.32	0.32	0.73 (0.24, 2.20) 1	0.57
Education level	Diploma/ certificate Degree/post-grad	0.32	0.32	1.38 (0.45, 4.17) 1	0.57
Level of responsibility	Facility District/ region	0.62	1.06	1.85 (0.57, 5.60) 1	0.30
Length of work	Length of work at facility	0.05	0.30	1.05 (0.88, 1.25)	0.58
Level of health facility	Clinic/ Health center Hospital	0.18	0.05	1.20 (0.25, 5.76) 1	0.82
Institution	Health facility/ district Region	−1.76	2.18	0.17 (0.02, 1.78) 1	0.14
Workshop training on PIS	Yes No	−0.29	0.23	0.75 (0.23, 2.45) 1	0.63
Rating technical expertise on PIS	Very/ extremely good Not/ somewhat good	−0.58	0.93	0.56 (0.17, 1.82) 1	0.33
Receipt of feedback on PIS	Receive feedback No feedback	0.07	0.01	1.08 (0.27, 4.27) 1	0.91
Mode of feedback	Formal written Verbal discussions	−0.74	0.68	0.48 (0.08, 2.76) 1	0.41
Frequency of feedback	Regular Irregular (once in 6 months/ annual/rare	−0.92	1.85	0.40 (0.11, 1.50) 1	0.17
Timeliness of feedback	Within expected timelines Outside expected timelines	−0.38	0.32	0.68 (0.18, 2.57) 1	0.57
Clarity of feedback	Always clear Sometimes/ not clear	−0.74	1.15	0.48 (0.12, 1.85) 1	0.28
Usefulness of feedback	Extremely useful Not so useful	0.71	2.84	2.03 (0.89,	0.09

(*continued on next page*)

Table 2 (*continued*)

Covariates		Beta coefficient (B)	Wald Chi-Squared Test	cOR (95% CI)	*p*-value
				4.62) 1	
Management ever consulted health workers on PIS	Yes No	−1.39	4.47	0.25 (0.07, 0.90) 1	0.03[a]
Method of consultation	Formal/ structured Informal/ verbal	0.25	0.05	1.29 (0.14, 11.54) 1	0.82
Management disseminates PIS information	Yes No	−0.80	0.92	0.45 (0.09, 2.29) 1	0.33
Structure exists for sharing PIS information	No Yes	0.08	0.02	1.08 (0.33, 3.56) 1	0.89
Rating need for PIS information	Extremely needed Somewhat needed	0.61	1.63	1.85 (0.72, 4.73) 1	0.20

B is the coefficient i.e. the magnitude of the effect of the covariate on the outcome (i.e. utility of PIS information) in a binary logistic regression model. The Wald test is a chi-squared test of association between the outcome (i.e. utility of PMIS/pharmaceutical information) and the individual covariates.

[a] Significant at 0.05 cut off. cOR = crude odds ratio.

Discussion

The study aimed to assess the extent and qualitative and quantitative predictors of utility of PIS data in public healthcare in Namibia. The secondary objective was to identify strategies to optimize utility of PIS data in public healthcare in resource limited settings.

The study found limited utility of PIS data in public healthcare facilities in Namibia, estimated at 60.7% (<80%–100%, target) among focal persons and/or public health facilities. When used, PIS data informed decisions on rational use of medicines and stock management as well as motivated for pharmacy workforce and, subsequently, reduced dispensing time. Similar uses of health information have been reported in other limited resource settings.[42] The sub-optimal use of PIS data a concern, given that PIS data informs decisions for the management and use of essential medicines. The extent of utility of health management information systems has been variably reported, with some studies indicating limited and others good utilization of information in LMICs. Our finding of 60.7% utilization is similar to 57.9% and 69.3% HMIS data utilization reported in Ethiopia,[24,25] with PIS information being a component of HMIS. Continued poor performance of pharmaceutical indicators in LMICs attests to possible limited utility of information.[2–5] Limited utilization of HMIS data was also reported in Pakistan and Rwanda, with just 32.9% in Ethiopia.[29–31] Hafner (2017) however reported good utilization of PIS information for quantification of medicines, especially antiretroviral (ARVs), but this is only part of the broader scope of pharmaceutical services.

This study found that the quantitative predictors for utility of PIS data for public healthcare in Namibia were sex, age, work experience, feedback on PIS data, technical expertise of PIS focal staff, and managers consulting of HCWs on PIS. The study found that respondents who were male, older, had stayed for a longer duration in their respective positions of responsibility, received feedback on PIS information, perceived such feedback as useful, had defined structures for disseminating PIS information, and had a highly rated need for PIS information were more likely to utilize the information compared to their counterparts,

Table 3
Themes of Factors that influence utility of PIS information.

a) Themes of factors that facilitate utility (n = 204)		Frequency (%)	Respondents' phrases
Category	Programmatic Technical Human	89(43.6) 77(37.7) 38(18.6)	
Programmatic (n = 89)	• Feedback, action and utilization of pharmaceutical information	23(25.8)	*"Plenty of opportunities & platforms to use to share PIS feedback to all healthcare workers".*
	• Structures, forums and technical support for PIS reporting, feedback, discussion	22(24.7)	*"Availability of PIS resources - manuals, data collection forms, etc".*
	• Resources for needed interventions for/on PIS recommendations	20(22.5)	*"Senior Medical Officer's demand for pharmacy information & using it".*
	• Staff engagement, motivation and communication	13(14.6)	*"Management support on taking action on decisions made from data".*
	• Staff compliance, target setting and action	6(6.7)	
	• Management interest	5(5.6)	
Technical (n = 77)	• Training/technical capacity of staff	41(53.2)	*"Availability of electronic record of PIS information makes it easy to retrieve old information".*
	• Tools and technical resources for data collection, reporting and utilization	29(37.7)	*"Ability to decode PMIS data and put interventions".*
	• Quality and relevance of PMIS data for utilization	7(9.1)	*"Making the outcomes of PMIS understandable by all cadres". "Indicators must be relevant and appeal to all HCWs". "Graphical feedback may be built into excel tool".*
Human (n = 38)	• Staff availability and workload	26(68.4)	*"Enough personnel to minimize workload".*
	• Culture and staff attitude	6(15.8)	*"Staffing plays a role in consistent collection of quality data".*
	• Staff commitment and team work	6(15.8)	*"willingness to improve service delivery".*
			"Availability of staff who are able to compile quality data".
b) Themes of factors that hinder utility (N=110)			
• Limited awareness/training/capacity		35(31.8)	*"Inadequate data gathering, analysis & interpretation skills".*
• Few staff/high workloads		19(17.3)	
• Poor quality of data		13(11.8)	
• Limited/late/no feedback		11(10.0)	*"Lack of understanding need to analyze, evaluate information for use".*
• Staff attitude/commitment		11(10.0)	
• Interrupted resource supply/Technical problems with PMIS system		10(9.1)	*"Inadequate trained human resource to monitor and follow up on recommended intervention strategies".*
• Limited management support/action on issues		5(4.5)	
• Inadequate forums for discussion/ communication		4(3.6)	
• Inadequate space for work/services		1(0.9)	*"Limited knowledge of pharmacist due to no proper orientation, training and mentoring for new staff (newly graduated from internship)".*
• Lack of incentives/rewards for good performers		1(0.9)	

although the results were not statistically significant. Utility of PIS information showed a significant association with management consultation of HCWs [cOR = 0.25; 95%CI (0.07, 0.90); $p = 0.03$]. The finding on limited feedback is similar to that of Mishra et al.,[43] while management consultation and data utility capacity aspects are similar to findings of a study done in Zanzibar[44] and one in five African countries.[45] Mutale et al. reported inadequate feedback and communication as hindrances to data utilization and emphasized the need to associate health information with decision making.[45] Few respondents, however, indicated the presence of defined structures for PIS information dissemination. It is likely that respondents who indicated an absence of structures for disseminating PIS information did not consider/explore utilizing existing structures like TC, DCC, management, and staff meetings. This calls for awareness and capacity enhancement of managers to recognize and utilize existing forums rather than think of creating forums specific for PIS information dissemination.

It is expected that older respondents and those who had been in positions for longer duration were likely more equipped with expertise in using the PIS information than fellow HCWs. HCWs' expertise plays a role in utility of health information. MoHSS may consider having more experienced managers as overseers of facilities/districts/regions to ensure utility of health information for improving services in public healthcare. Older, experienced, competent managers with the right attitude can command more respect and enforce compliance for implementation of targeted interventions – as some respondents also suggested poor compliance to established guidelines and that targets should be set and monitored with recommendations acted upon. An aspect of retention of staff in posts or at least ensure continuity in staff establishment is key.

Findings also revealed that respondents who were female, married, pharmacists, had benefitted from workshop training on PMIS, with degree/post-graduate qualification, received formal written, and regular (quarterly) and clear feedback were less likely to utilize PIS information. Also, staff in charge of pharmaceutical management whose technical expertise was rated as very/extremely good were found to be less likely to utilize PIS information compared to those rated as not so good/somewhat good. The findings, especially with regard to pharmacists and those rated as having good expertise, are surprising but explained by qualitative information on factors that influence utility of PIS information where aspects of attitude and management support were mentioned. This shows that utility of information to improve pharmaceutical services in public healthcare needs HCWs with sufficient knowledge and the right attitude with commitment to utilize PIS information to improve pharmaceutical services. This finding on attitude and commitment is similar to that reported by Nyamtema.[46] The more qualified and those rated as very/extremely good on PIS but not using the information can be targeted, challenged, and motivated with quality improvement initiatives which will cause them to use information.

The finding on association of training with utility of health and PIS information although surprising is not unique. In Tanzania, training was found not to have improved quality, and possibly utility of HMIS data with a key recommendation to review training approaches.[47] Limited training on HMIS was also reported in India,[43] but Braa et al. reported that workshops on data use had impacted on utilization of HMIS information.[48] Many institutions resort to training as the major strategy for enhancing capacity of staff. Regrettably, training efforts do not necessarily translate into improved quality and utility of health information despite many institutions' heavy investments in them. Yes, training sessions are useful forums for imparting knowledge and skill, but the mode of delivery of training and other capacity building endeavors like support supervision and on-the-job mentoring need to be critically thought through; their implementation should be enhanced with continuous monitoring, planning, and quality improvement. Simba and Mwangu (2011) also recommended rethinking training approaches.[47] Monitoring, training and planning (MTP) approach has been reported to be an effective approach to enhancing capacity of HCWs to address pharmaceutical issues and improve services in their workplaces.[49,50] Thus training, if well planned, targeted, and monitored can improve quality and utility of information. A critical review of methodologies applied in training and other forms of capacity building such as supportive supervision is needed and urgent given dwindling resource support from donors to developing countries.[47,51]

Regular, timely, and clear feedback is expected to enhance the utility of information to guide subsequent interventions/service delivery. This study found the contrary. Effectiveness of feedback on PIS information, its mode of delivery, targeted cadres/recipients of the information, and attitude of those who receive it is a concern that requires further study. The feedback may be a formality in compliance with set standards but limited on impact. This calls for follow up on recommendations in feedback, action planning, and follow up on implementation of such actions. Benn et al. reported that effective delivery of feedback,[52] structured planning, and monitored implementation of actions was necessary to yield desired results; in this study, the desired result is to improve pharmaceutical services in public healthcare. A study on utility of PIS information in Namibia in 2017 also noted that availability of information does not guarantee its utility.[27] Thus, effort is needed to facilitate utility of such information with capacitated staff with good attitude, commitment to compliance and quality service, a conducive environment with management support and uninterrupted availability of resources for needed interventions. In addition, feedback should be actionable to guide interventions.[52] Indeed, limited resources like funding from government affected quality and utility of data in Malawi.[53] Respondents indicated a very high need for PIS information to inform decisions; this could point to an unmet need for feedback on PIS information as evidenced by listed factors influencing utility and subsequent recommendation for more timely feedback.

A study among 720 HCWs in Ethiopia found sex, nature of institution, data analysis skills, and governance were significant contributors to good utilization of health information.[36] Covariates in our study similar to those in the Ethiopian study associated with PIS utilization were sex, feedback and dissemination of PIS information and management consultations on PIS that relate to governance, and technical expertise of the people responsible for PIS.

The study found that the qualitative drivers of utility of PIS data for public health care in Namibia were related to programmatic, technical, and human resource capabilities. In particular, programmatic challenges were related to timeliness, usefulness, clarity, and mode of feedback. HCWs not only need feedback and guidance to utilize information, they require the MoHSS to provide resources for implementation of recommendations as evidenced by the PIS performance; managers to be interested in and support staff in the needed interventions. Technical factors, especially staff capacity and efficiently running systems for PIS data collection, analysis, and reporting, were highlighted as key in ensuring quality of data collected, processed, reported, and utilized to influence decisions for public healthcare. KIs indicated concerns with quality of PIS data, as also did a Namibian study,[54] and recommended data validation, capacity enhancement, and follow up on reports. Studies in other LMICs have reported that technical factors, staff capacity, quality, and timeliness of PIS data influence utility of the information.[27,55]

Human factors, mainly availability of sufficient numbers of qualified staff with the right attitude and commitment, were listed as influencing utility of PIS information. This finding reverberates with that of other scholars/researchers who have recommended addressing programmatic, technical, and human resource factors, e.g. enhancing capacity both for technical and management staff, addressing human resource gaps and attitudes, enhancing utility of generated information to create even more demand, and ensuring uninterrupted availability of resources like pharmaceuticals for continued care for patients.[27,29]

Human resources with all required technical expertise will, however, never be enough so institutions need to maximize on the existing resources, use of automated systems for collation of data, automated

aggregation and reporting, access to information, and recommendations by all managers and relevant staff for action. The PIS data need to be broken down into practicable pieces, with an automated system to flag anomalies and offer recommendations for decision-makers within public healthcare.

The main strategies for optimizing the utility of PIS data for public healthcare were.

(1) **adequately capacitating and supporting HCWs** to effectively implement PMIS and utilize information generated for improving pharmaceutical care. Otherwise, HCWs remain passive in PIS data utilization. HCWs who receive feedback, have their managers disseminate the information, and act on recommendations influences utility of information with confidence. Otherwise, recommendations on poorly performing indicators that are not acted upon make the HCWs feel like a waste of time. The utility of data enhances its quality which also makes users more confident to utilize it for decision making.[53] Utility of quality information to target interventions to improve healthcare plays an important role in quality of care and overall health outcomes. Respondents' highlighted examples of the impact of utilization of information, and ensuing quality of patient care and client satisfaction evidenced by reduced complaints, are testimony to the value of using information for evidence-based action.

(2) **Timely dissemination of quality feedback and supporting HCWs and managers to utilize the information.** This entails addressing the identified programmatic, technical, and human resource factors to enhance utility of PIS information as key, as availability of PIS information is not an end in itself. Instead, the utilization of information for decisions to improve healthcare is the ultimate goal. Such factors as addressing quality of indicators and data; creating awareness and enhancing capacity of staff and managers on pharmaceutical data collection, processing, and utilization; timely, useful and effective feedback; and access to information and technical support were recommended by other researchers/programmers.[24,25,29,31,42–44,47,50–53,56–59]

(3) **Need to address quality of indicators and data** that reportedly influences utility of the information in LMICs.[48,60] The sub-optimal data quality concern was also reported in a Namibian PIS study,[54] while Niaz et al. reported on quality of indicators.[17] Revision of PIS indicators is urgent and highly desired to include service level indicators as well as improve some indicators for more accurate measurements than currently described in the PMIS manual.[39] As one respondent reiterated, "*Add more indicators in pharmaceutical care as most current ones are related to pharmaceutical supply. No indicators to assess patient outcomes, adverse events*"; "*Review some PIS tally sheets (tools) e.g. conflict between actual situation (availability) vs tally sheet score demotivates*"; "*Review of some PIS indicators e.g. HF11, considering patients with multiple diseases that are on so many medications. PIS just counts all medicines*". Furthermore, to enhance the utility of PIS information, more robust quality indicators should be developed for the ambulatory care sector in Namibia with high rates of both infectious and non-infectious diseases.[17]

Limitations

The study findings should be interpreted considering that the assessment utilized a sample/proportion of MoHSS managers and facility/district/regional focal persons for generalizability to all public health facilities in Namibia. Managers or designated HCWs at district level operate at the hospital level with more engagement in TC and meetings that oversee medicine use and service delivery at that level as opposed to focal persons at health centers and clinics. Utility of information for public health services may, thus, be affected by the variance in levels of healthcare. Nonetheless, this is the first study assessing utility of PIS information up to facility level; hence findings are an eye-opener for key programmatic and technical interventions to improve utility of information.

Conclusion and recommendations

There is sub-optimal utility of PIS information for improving pharmaceutical services in public healthcare in Namibia. A good number of respondents could not point out any evidence of utility of information, implying limited monitoring of pharmaceutical services. Several programmatic, technical, and human resource related factors influence quality and utility of pharmaceutical information. Staff and managers' awareness and capacity enhancement, implementation of PMIS recommendations, quality feedback, enhanced access to information, quality comprehensive PIS indicators, and enhanced opportunities for sharing PIS information were recommended to improve utility of pharmaceutical information.

Thus, based on evidence from this study, it is recommended that the identified factors are addressed and an automated system for PIS data analysis, real-time feedback, automatic decision making systems/intelligence systems, and recommended action with outputs accessible to managers at all levels is implemented. A model to guide improvement in quality and utility of PIS data is a useful resource.[61] An app may be developed for managers to access PIS data at all levels to self-assess performance and use information for action to improve quality of healthcare. An automated pharmaceutical intelligence system has potential to improve timeliness of PIS data analysis, feedback, and access to important metrics at modest cost to staff and managers, while bypassing current bottlenecks in the dissemination of feedback and its eventual utility for improving pharmaceutical services in public healthcare for better treatment outcomes.

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Declaration of competing interest

The authors have no conflict of interest to declare.

CRediT authorship contribution statement

H.R. Kagoya: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing - original draft. **T.W. Rennie:** Conceptualization, Writing - review & editing. **D. Kibuule:** Investigation, Writing - review & editing. **H.K Mitonga:** Conceptualization, Writing - review & editing.

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Appendix A. Supplementary data

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References

1. Ortblad KF, Lozano R, Murray CJL. The burden of HIV. *AIDS*. 2013;27(13): 2003–2017. https://doi.org/10.1097/QAD.0b013e328362ba67.

2. Bilal AI, Osman ED, Mulugeta A. Assessment of medicines use pattern using World Health Organization's Prescribing, Patient Care and Health facility indicators in selected health facilities in eastern Ethiopia. *BMC Health Serv Res*. 2016. https://doi.org/10.1186/s12913-016-1414-6.
3. Kagoya HR, Mitonga HK, Kibuule D, Rennie T. Effectiveness of implementation of national treatment guidelines on medicine use indicators in Namibia: implications for resource- limited settings (under review). *J Health Manag*. 2020. Submitted for publication.
4. Atif M, Sarwar MR, Azeem M, Naz M, Amir S, Nazir K. Assessment of core drug use indicators using WHO/INRUD methodology at primary healthcare centers in Bahawalpur, Pakistan. *BMC Health Serv Res*. 2016. https://doi.org/10.1186/s12913-016-1932-2.
5. Ofori-Asenso R, Brhlikova P, Pollock AM. Prescribing indicators at primary health care centers within the WHO African region: a systematic analysis (1995-2015). *BMC Publ Health*. 2016. https://doi.org/10.1186/s12889-016-3428-8.
6. Ofori-Asenso R, Agyeman A. Irrational use of medicines—a summary of key concepts. *Pharmacy*. 2016. https://doi.org/10.3390/pharmacy4040035.
7. Kibuule D, Mubita M, Naikaku E, Kalemeera F, Godman BB, Sagwa E. An analysis of policies for cotrimoxazole, amoxicillin and azithromycin use in Namibia's public sector: findings and therapeutic implications. *Int J Clin Pract*. 2017. https://doi.org/10.1111/ijcp.12918.
8. Who. *Promoting Rational Use of Medicines: Core Components Patient Care Indicators*. WHO Policy Perspect Med; 2002. https://www.who.int/medicines/publications/policyperspectives/ppm05en.pdf.
9. Krishnan A, Nongkynrih B, Yadav K, Singh S, Gupta V. Evaluation of computerized health management information system for primary health care in rural India. *BMC Health Serv Res*. 2010;10:310. https://doi.org/10.1186/1472-6963-10-310 [doi] 1472-6963-10-310 [pii].
10. Sharma A, Rana SK, Prinja S, Kumar R. Quality of health management information system for maternal & child health care in Haryana state, India. *PloS One*. 2016;11(2). https://doi.org/10.1371/journal.pone.0148449.
11. Strachan M, Rawlins B, Levine B. Strengthening health management information systems for maternal and child Health : documenting MCHIP ' s contributions. Paper. December http://www.mchip.net/sites/default/files/Strengthening Health Management Information Systems.pdf; 2013.
12. Nisingizwe MP, Iyer HS, Gashayija M, et al. Toward utilization of data for program management and evaluation: quality assessment of five years of health management information system data in Rwanda. *Glob Health Action*. 2014. https://doi.org/10.3402/gha.v7.25829.
13. Atif M, Sarwar MR, Azeem M, Naz M, Amir S, Nazir K. Assessment of core drug use indicators using WHO/INRUD methodology at primary healthcare centers in Bahawalpur, Pakistan. *BMC Health Serv Res*. 2016;16(1):1–9. https://doi.org/10.1186/s12913-016-1932-2.
14. Godman B, Haque M, McKimm J, et al. Ongoing strategies to improve the management of upper respiratory tract infections and reduce inappropriate antibiotic use particularly among lower and middle-income countries: findings and implications for the future. *Curr Med Res Opin*. 2020. https://doi.org/10.1080/03007995.2019.1700947.
15. Nisingizwe MP, Iyer HS, Gashayija M, et al. Toward utilization of data for program management and evaluation: quality assessment of five years of health management information system data in Rwanda. *Glob Health Action*. 2014. https://doi.org/10.3402/gha.v7.25829.
16. Gustafsson LL, Wettermark B, Godman B, et al. The 'wise list'- A comprehensive concept to select, communicate and achieve adherence to recommendations of essential Drugs in ambulatory care in stockholm. *Basic Clin Pharmacol Toxicol*. 2011. https://doi.org/10.1111/j.1742-7843.2011.00682.x.
17. Niaz Q, Godman B, Massele A, et al. Validity of World Health Organisation prescribing indicators in Namibia's primary healthcare: findings and implications. *Int J Qual Health Care*. 2018;(August):1–8. https://doi.org/10.1093/intqhc/mzy172.
18. Mashalla Y, Setlhare V, Massele A, et al. Assessment of prescribing practices at the primary healthcare facilities in Botswana with an emphasis on antibiotics: findings and implications. *Int J Clin Pract*. 2017. https://doi.org/10.1111/ijcp.13042.
19. Cheraghali AM, Idries AM. Availability, affordability, and prescribing pattern of medicines in Sudan. *Pharm World Sci*; 2009. https://doi.org/10.1007/s11096-009-9282-3. https://www.academia.edu/11442409/Availability_affordability_and_prescribing_pattern_of_medicines_in_Sudan.
20. Holloway K. Promoting the rational use of antibiotics. *Reg Heal Forum*. 2011;15(1):122–130.
21. Dias V. MDS-3: managing access to medicines and health technologies (Chapter 9) *Manag Sci Heal*. 2012. https://doi.org/10.1016/j.trstmh.2011.09.008 (Journal).
22. Lippeveld T. Routine health facility and community information systems: creating an information use culture. *Glob Heal Sci Pract*. 2017;5(3):338–340. https://doi.org/10.9745/GHSP-D-17-00319.
23. Chikumba PA, Ramussen SL. Management and use of health information in Malawi and Burkina Faso: the role of technology. In: *2016 IST-Africa Conference, IST-Africa 2016*. 2016. https://doi.org/10.1109/ISTAFRICA.2016.7530625.
24. Yarinbab TE, Assefa MK. Utilization of HMIS data and its determinants at health facilities in east wollega zone , oromia regional state , Ethiopia : a health facility based cross-sectional study. *J Med Heal Sci*. 2018;7(1):4–9. http://www.rroij.com/open-access/pdfdownload.php?aid=86724, 2018.
25. Abera E, Daniel K, Letta T, Tsegaw D. Utilization of health management information system and associated factors in hadiya zone health centers, southern Ethiopia. *Res Heal Sci*. 2016. https://doi.org/10.22158/rhs.v1n2p98.
26. Mabirizi D, Phulu B, Churfo W, et al. Implementing an integrated pharmaceutical management information system for antiretrovirals and other medicines: lessons from Namibia. *Glob Heal Sci Pract*. 2018. https://doi.org/10.9745/GHSP-D-18-00157.
27. Hafner T. The use of pharmaceutical information for decision making in Namibia's national ART program: assessment report. http://siapsprogram.org/publication/the-use-of-pharmaceutical-information-for-decision-making-in-namibias-national-art-program-assessment-report/; 2017.
28. Mashaba TP, Matlala M, Godman B, Meyer JC. Implementation and monitoring of decisions by pharmacy and therapeutics committees in South African public sector hospitals. *Expet Rev Clin Pharmacol*. 2019. https://doi.org/10.1080/17512433.2018.1545572.
29. Qazi MS, Ali M. Pakistan's health management information system: health managers' perspectives. *J Pakistan Med Assoc*. 2009;59(1):10–14.
30. Innocent K, Anguyo R, Onzima D, Katongole S-P, Govule P. Quality and use of routine healthcare data in selected districts of eastern province of Rwanda. *Int J Public Heal Res*. 2016;4(2):5–13.
31. Abajebel S, Jira C, Beyene W. Utilization of health information system at district level in jimma zone oromia regional state, South west Ethiopia. *Ethiop J Health Sci*. 2011;21(Special Issue):65–76.
32. Laschober M, Maxfield M, Felt-Lisk S, Miranda DJ. Hospital response to public reporting of quality indicators. *Health Care Financ Rev*. 2007;28:61–76. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med5&AN=17645156. http://sfx.scholarsportal.info/mcmaster?sid=OVID:medline&id=pmid:17645156&id=doi:&issn=0195-8631&isbn=&volume=28&issue=3&spage=61&pages=61-76&date=2007&title=Health+Care.
33. Macharia J, Maroa C. Health management information systems (HMIS) implementation characteristics that influence the quality of healthcare in private hospitals in Kenya. In: *2014 IST-Africa Conference and Exhibition, IST-Africa 2014*. 2014. https://doi.org/10.1109/ISTAFRICA.2014.6880631.
34. Mutemwa RI. HMIS and decision-making in Zambia: Re-thinking information solutions for district health management in decentralized health systems. *Health Pol Plann*. 2006;21(1):40–52. https://doi.org/10.1093/heapol/czj003.
35. Sadoughi F, Sarsarshahi A, Eerfannia I, Ali Khatami Firouzabad SM. Ranking evaluation factors in hospital information systems. *Hum Vet Med*. 2016;8(2):92–97. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84996549551&partnerID=40&md5=f8bdec0c8d09fcaf7d8f2e7fb0ade14f.
36. Dagnew E, Woreta SA, Shiferaw AM. Routine health information utilization and associated factors among health care professionals working at public health institution in North Gondar, Northwest Ethiopia. *BMC Health Serv Res*. 2018;18(1). https://doi.org/10.1186/s12913-018-3498-7.
37. McQuide PA, Kolehmainen-Aitken RL, Forster N. Applying the workload indicators of staffing need (WISN) method in Namibia: challenges and implications for human resources for health policy. *Hum Resour Health*. 2013;11(1). https://doi.org/10.1186/1478-4491-11-64.
38. Prakasam KCA, Riyas SKN. Assessment of prescribing trends and rationality of drug prescribing using WHO indicators in Malappuram District, India. *J Pharm Res*. 2012;5:3189–3192.
39. Ministry of Health and Social Services (MoHSS). Namibia pharmaceutical management information system (PMIS). *Manual*. 2012;September.
40. Kagoya HR, Mazibuko G, Phulu B, Mwinga S, Sagwa E. *SIAPS Namibia End of Project Report*. 2018.
41. Phulu B, Ludman M, Kagoya H. National pharmacists ' forum 2014 technical Report : dissemination of pharmaceutical services information. http://apps.who.int/medicinedocs/documents/s22006en/s22006en.pdf; 2014.
42. Hazel E, Chimbalanga E, Chimuna T, et al. Using data to improve programs: assessment of a data quality and use intervention package for integrated community case management in Malawi. *Glob Heal Sci Pract*. 2017;5(3). https://doi.org/10.9745/ghsp-d-17-00103.
43. Mishra A, Vasisht I, Kauser A, Thiagarajan S, Mairembam DS. Determinants of Health Management Information Systems performance: lessons from a district level assessment. *BMC Proc*. 2012. https://doi.org/10.1186/1753-6561-6-s5-o17.
44. B J, H A, S S. Improving quality and use of data through data-use workshops: Zanzibar, United Republic of Tanzania. *Bull World Health Organ*. 2012. https://doi.org/10.2471/BLT.11.099580.
45. Mutale W, Chintu N, Amoroso C, et al. Improving health information systems for decision making across five sub-Saharan African countries: implementation strategies from the African Health Initiative. *BMC Health Serv Res*. 2013. https://doi.org/10.1186/1472-6963-13-S2-S9.
46. Nyamtema AS. Bridging the gaps in the health management information system in the context of a changing health sector. *BMC Med Inf Decis Making*. 2010. https://doi.org/10.1186/1472-6947-10-36.
47. Simba D, Mwangu M. Factors influencing quality of health management information system (HMIS) data: the case of Kinondoni district in Dar es Salaam region, Tanzania. *East Afr J Publ Health*. 2011. https://doi.org/10.4314/eajph.v3i1.38967.
48. Braa J, Heywood A, Sahay S. Improving quality and use of data through data-use workshops: Zanzibar, United Republic of Tanzania. *Bull World Health Organ*. 2012. https://doi.org/10.2471/blt.11.99580.
49. Matowe L, Waako P, Adome RO, Kibwage I, Minzi O, Bienvenu E. A strategy to improve skills in pharmaceutical supply management in East Africa: the regional technical resource collaboration for pharmaceutical management. *Hum Resour Health*. 2008. https://doi.org/10.1186/1478-4491-6-30.
50. Wolde LA, Kagoya HR. *Improved pharmaceutical inventory management in Namibia through monitoring training planning*. 2018 (January). file:///C:/Users/User/Desktop/Study/PMIS utilisation/Case-Study-19_Improved-Pharmaceutical-Inventory-Management-in-Namibia_122717.pdf.
51. Laing R. Ten recommendations to improve use of medicines in developing countries. *Health Pol Plann*. 2001. https://doi.org/10.1093/heapol/16.1.13.

52. Benn J, Koutantji M, Wallace L, et al. Feedback from incident reporting: information and action to improve patient safety. *Qual Health Care*. 2009. https://doi.org/10.1136/qshc.2007.024166.
53. Kumwenda B, Jimmy-Gama D, Manyonga V, Semu-Kamwendo N, Nindi-Mtotha B, Chirwa M. *Factors Affecting Data Quality in the Malawian Health Management Information System*. 2014. https://doi.org/10.2316/p.2014.815-028.
54. Kagoya HR, Kibuule D, Rennie TW, Wuletaw C, Mitonga KH. Optimizing data quality of pharmaceutical information systems in public health care in resource limited settings. *Res Soc Adm Pharm*. 2019. https://doi.org/10.1016/j.sapharm.2019.09.057.
55. Kumar M, Gotz D, Nutley T, Smith JB. Research gaps in routine health information system design barriers to data quality and use in low- and middle-income countries: a literature review. *Int J Health Plann Manag*. 2018;33(1). https://doi.org/10.1002/hpm.2447.
56. Qazi MS, Ali M. Health management information system utilization in Pakistan: challenges, pitfalls and the way forward. *Biosci Trends*. 2011. https://doi.org/10.5582/bst.2011.v5.6.245.
57. Khalifa M, Alswailem O. *Hospital Information Systems (HIS) Acceptance and Satisfaction: A Case Study of a Tertiary Care Hospital*. Procedia Computer Science; 2015. https://doi.org/10.1016/j.procs.2015.08.334.
58. Levenger M, Ongeri B, Wolde A, Kagoya HR. *Namibia National Supply Chain Assessment*. 2013.
59. Shiferaw AM, Zegeye DT, Assefa S, Yenit MK. Routine health information system utilization and factors associated thereof among health workers at government health institutions in East Gojjam Zone, Northwest Ethiopia. *BMC Med Inf Decis Making*. 2017;17(1). https://doi.org/10.1186/s12911-017-0509-2.
60. Manya A, Nielsen P. Reporting practices and data quality in health information systems in developing countries: an exploratory case study in Kenya. *J Health Inform Dev Ctries*. 2016;10(1):114–126.
61. Kagoya HR, Kibuule D, Rennie WT, Mitonga KH. A model for strengthening utility of quality pharmaceutical health systems data in resource-limited settings (under review). *Med Access @ Point Care*. 2020. Submitted for publication.