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A model to strengthen utility of quality pharmaceutical health systems data in resource-limited settings

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Abstract

Background: Limited utility of quality health data undermines efforts to strengthen healthcare delivery, particularly in resource-limited settings. Few studies model the effective utility of quality pharmaceutical information system (PIS) data in sub-Saharan Africa, typified with weak health systems.
Aim: To develop a model and guidelines for strengthening utility of quality PIS data in public healthcare in Namibia, a resource-limited setting.
Methods: A qualitative model based on Dickoff et al. practice-oriented theory, Chinn and Jacobs' systematic approach to theory, and applied consensus techniques. Data from nationwide studies on quality and utility of PIS data in public healthcare conducted between 2018 and March 2020 informed the development of the model concepts. Pharmaceutical and public health systems experts validated the final model.
Results: Overall, four preliminary national studies that recruited 58 PIS focal persons at 38 public health facilities and national level informed the development of four model concepts. The model describes concepts on access, management, dissemination, and utility of quality PIS data. Activities to implement the model in practice include grass-root integration of real-time automated pharmaceutical intelligence systems to collect, consolidate, monitor, and report PIS data. Strengthening coordination, human resources, and technical capacity through support supervisory systems at grass-root facilities are key activities. PIS focal persons at health facility and national level are agents to implement these activities among recipients, that is, healthcare professionals at points of care. Guidelines for implementation of the model at point of care are included. Experts described the model as clear, simple, comprehensive, and integration of pharmaceutical intelligence systems at point of care as novel and of importance to enhance utility of quality PIS data in resource-limited settings.
Conclusion: While utility of quality PIS data is limited in Namibia, advantages of the model are encouraging, toward building resilient pharmaceutical intelligence systems at grass roots in resource-limited countries, where there are not only weak health systems, but high burden of misuse of medicines.

Keywords

Data, health, information systems, pharmaceutical, quality, utility

Introduction

Poor quality of health systems data undermines public healthcare delivery, particularly in resource-limited countries, characterized with weak healthcare systems.[1,2] Though prevalent worldwide, sub-optimal quality and utility of health systems information is disproportionately higher among countries in sub-Saharan Africa, including Namibia.[1,2] Low quality and utility of health systems data

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is a barrier to universal health care coverage in sub-Saharan Africa, given the high burden of disease, irrational use of medicines against weak health surveillance systems.[3] Moreover, the World Health Organization (WHO) estimates the burden of irrational use of medicines globally above 50%, this is higher in resource-limited countries.[4,5] In Namibia, despite nationwide implementation of pharmaceutical information system (PIS) in public healthcare, the indicators for rational use of medicines remain below the WHO targets.[6]

Consequently, most resource-limited countries have scaled-up integration of health management information systems (HMIS) in public healthcare to improve quality and utility of data.[2,7–12] In 2007, a nationwide PIS was rolled out in Namibia at public health facilities in all 14 regions.[13] Data generated from the national PIS informs decisions regarding rational use of medicines, supply chain, and management, among others.[14,15] Implementation and surveillance of national PIS in resource-limited countries such as Namibia is largely donor-supported; this is not sustainable in terms of quality.[16,17] Thus, it is not surprising that limited utility of quality PIS data remains an important bottleneck to healthcare delivery in these settings in public healthcare.[18,19]

Previously, the authors have described challenges with quality and utility of PIS data and indicators, as well as misalignment of PIS indicators with National Standard Treatment Guidelines (NSTGs) for Namibia implemented in 2011.[20–22] The utility of PIS data among focal persons at public health facilities in Namibia was estimated at 60.7% (target >80%).[15] In addition, the authors have described three thematic drivers of utility of data: weak program implementation, limited technical capacity or human resources.[15] Several studies among resource-limited countries describe predictors of PIS data quality including health facility or human resource related.[2,8,12,15,23,24]

Nevertheless, few studies systematically model the utility of quality PIS data in resource-limited settings, given the high burden of disease and irrational medicine use. This calls for a comprehensive model to inform decisions on quality assurance and utility of PIS data to improve healthcare delivery.[25] Consequently, the study aim was to develop a model and guidelines for enhancing quality and utility of pharmaceutical data to improve medicines monitoring and evaluation of programs in resource-limited settings.

Methods

Main outcome measures

Primary outcome was an optimal model depicting concepts, goal, activities, interlinkages, and guidelines to enhance quality and utility of PIS data.

Design and setting

A qualitative model design utilized two theories, Dickoff et al.[26] practice-oriented theory and Chinn and Jacobs'[27] systematic approach to theory, and consensus techniques among pharmaceutical and public health experts. Four nationwide surveys on quality and utility of PIS data in Namibia's public healthcare from 2018 to March 2020 informed the specific elements in the development of the model.[6,12,15,21] Namibia has a population of 2.3 million people served by over 300 health facilities organized at three tiers—hospitals, health centers, and clinics.[28] In Namibia, access to health and pharmaceutical services are free in public facilities, with patients only paying a minimal administration fee (~USD$0.3–2.0). The PIS database shows data aggregated from 38 public health facilities, mainly hospitals since 2007.

PIS in Namibia

Implemented from 2007 at public health facilities in Namibia, the PIS gathers data on indicators, pharmaceutical resources, management, and use of essential medicines.[29] Data at the health facility is first captured manually using paper-based forms at the points of care and subsequently entered into an electronic PIS database by pharmacists or designates and aggregated at district level. The Division of Pharmaceutical Services in the Ministry of Health and Social Services (MoHSS) provides support-supervision of PIS activities. Quarterly reporting on PIS indicators is coordinated at facility, district, region, and national levels. Currently, PIS data are not integrated in the national HMIS of Namibia.

Surveys on quality and utility of PIS data in Namibia

Findings from four studies among 58 PIS focal persons at 38 public health facilities in all the 14 regions of Namibia informed the development of concepts for the model. The first study, an analysis of the national PIS database typically found that though availability of data was high, the quality of data was sub-optimal, that is, incomplete and inconsistent.[12] Second study, a time-series analysis found limited improvement in PIS indicators despite implementation of NSTGs of 2011.[6] The third study found discordance between PIS indicators and NSTGs.[21] The fourth study established low utility of PIS data as well as three key drivers: weak PIS implementation, limited human resources and technical capabilities.[15] Where utilized, PIS data guided decisions on rational medicine use, management of pharmaceuticals, and strengthening pharmacy workforce.[15]

Procedure for development of the model

Findings from the four national surveys informed development of the model concepts, that is, data quality, management, dissemination/feedback, access, and utility. Thereafter, the development of the model involved seven stages including naming concepts, isolating concepts and sub-concepts, describing three key ingredients, establishing interlinkages among concepts and activities, describing six components of the survey-list (guidelines), identifying assumptions, as well as validation of the model by experts.[26,27] According to Dickoff et al.,[26] three key ingredients are needed for the model: "goal-content; prescription for the activity; and a survey-list." The survey-list guides implementation of activities. Model activities are termed "prescriptions for activity" by Dickoff et al.[26] The activities identified from the studies should be implemented in an integrated manner. Consequently, descriptive analysis and conceptualization of concepts guided the interlinkages and construction of the final model. The final model was validated for clarity, simplicity, generality, accessibility, applicability, and importance. The experts were purposively selected based on familiarity with the PIS in Namibia, public health systems, model development, and postgraduate qualification in pharmaceutical/public health. Finally, model implementation guidelines were described in terms of Dickoff et al.[26] six features of the survey-list: agent, recipient, context, dynamics, procedure, and terminus. Guidelines ensure clarity and support implementation of activities toward the goal.

Results

Summary of demographics of opinion experts and study findings

Six opinion experts validated the model, three pharmaceutical and three public health; 5/6 are PhD holders. Typically, PIS data were incomplete and inaccurate, poorly utilized and indicators thereof poorly aligned with national treatment protocols. This was majorly due to weak PIS program implementation, and limited human and technical resources at points of care.[15]

Concepts and sub-concepts

Table 1 shows six concepts and sub-concepts and their definitions derived from the four studies to strengthen quality and utility of PIS data in Namibia (Table 1).

Three key ingredients for the model

Subsequently, three model ingredients were derived from the concepts (Figure 1).

Goal of the model

The ultimate goal is to strengthen quality and utility of information to improve quality of pharmaceutical care. Optimal utility is considered at >80% of target managers using information for decisions and interventions to improve quality of care, minimize wastage of pharmaceutical products, prevent development of antimicrobial resistance (AMR). Data for decision-making should be of high quality, otherwise managers do not use it.[30–32]

Interlinkages among concepts and activities

Figure 2 illustrates the interlinkages of seven activities aligned to the model concepts. These include collecting of quality data, implementing an automated pharmaceutical intelligence system, advocating for and creating awareness, addressing technical factors including policy guidelines, addressing human resource factors and performance monitoring, follow-up, and accountability of performance.

Model application: activities to achieve the goal of enhanced quality and utility of data at grassroot level

Table 2 describes seven model activities to be implemented to enhance utility of quality PIS data in resource-limited settings (Table 2). The activities pertain to collecting quality data, implementing an automated pharmaceutical intelligence system, advocating for and creating awareness on PIS among healthcare professionals, addressing factors that impact of utility of PIS data. The factors are program related such as forums for disseminating PIS information and resources for auctioning recommendations on the indicators; technical factors including policy guidelines, human resource factors and performance monitoring, follow-up, and accountability of performance.

The model and guidelines (survey-list) for implementing the activities

Guidelines for implementing the model are described below. They include description of the agents, recipients/implementers, context, dynamics/motivating factors, activities/procedures, the goal and assumptions, and how these are interlinked in the consolidated model (Figure 3).

The agents. Agents spearhead and support implementation of activities. The agents for the model are the MoHSS managers and PIS focal staff responsible for pharmaceutical service oversight at health facilities, districts, regions, and national level. The agents advocate for and create awareness on pharmaceutical aspects among target healthcare workers (HCWs) who include prescribers (physicians and nurses) and pharmacy staff. These target HCWs

Table 1. Model concepts and sub-concepts for strengthening utility of quality PIS data..

Concepts (study sources)	Definition of the concept	Sub-concepts
Improve *Data quality*[12,15,21]	*Data quality* refers to the state of qualitative and quantitative pieces of information. Data quality is defined in terms of four attributes: timeliness, completeness, validity, and accuracy as measures of its fitness for intended use in operations, decisions, and planning.[23–25]	Improve: • Timeliness • Completeness • Validity • Accuracy
Enhance *Data management*[6,12,15,21,22]	*Data management* is the process of acquiring, validating, storing, protecting, and processing required PIS data to ensure accessibility, reliability, and timeliness for its users.[36]	Enhance and facilitate: • Data quality assurance • Aggregation • Analysis • Summary generation/compilation of a report with recommendations
Enhance *Dissemination/feedback and access to information*[6,12,15,21,22]	*Dissemination/feedback* entails sharing through presenting and distributing data that was collected, analyzed, and compiled with the public or target users. The public includes those who contributed to the data.	Sharing feedback on the report: • Findings on performance • Recommendations for action • Engaging all healthcare workers and managers
Enhancing *data quality and utility*[6,12,15,21,22]	*Access to information* encompasses enabling target users of information to get it from systems so that they can use it.[37] *Utility of data* means the amount of the data that is utilized. A target of >80% of managers using data is ideal.	Addressing factors that impact on quality and utility of data: • Data quality aspects • Programmatic factors • Technical factors including policy guidelines • Human resource factors • Advocacy and awareness on PIS • Action on recommendations
Improved quality of pharmaceutical care[6,12,15,20,21,22]	*Quality of pharmaceutical care* with respect to the model comprises dispensing medicines prescribed for the patient (target = 100%),[29] rational use of medicines supported by quality STGs,[16] compliance to NSTGs-recommended prescribing, adequate information to and counseling of patients on their medicines; dispensing medicines according to the pharmaceutical SOPs[38] and sufficient HCWs per national targets[29] to offer quality care.	Improve quality of pharmaceutical care through utilization of PIS data to ensure: • Availability of medicines • Rational use of medicines • Limited waiting time for patients

PIS: pharmaceutical information system; STGs: Standard Treatment Guidelines; NSTGs: National Standard Treatment Guidelines; SOPs: standard operating procedures; HCWs: healthcare workers.

engage patients on diagnosis, prescribing, and medicine use aspects. National-level managers support the target HCWs on pharmaceutical services; motivate for, facilitate or coordinate pharmaceutical management-related trainings and technical support; PIS implementation; and are accountable to the MoHSS for the performance of pharmaceutical services in the country. The managers will also advocate for and ensure appropriate design, implementation and oversight of the automated pharmaceutical intelligence system, its continued functionality and upgrades. The national-level managers are also responsible for ongoing evaluation and quality improvement of pharmaceutical services. They liaise with the overall MoHSS management to ensure availability of medicines and policy guidelines for pharmaceutical services.

Agents may include resources other than people.[26] Therefore, the pharmaceutical intelligence system is also an agent as it will enable timely data quality checks, aggregation, and feedback.[15] The Pharmaceutical Management Information System (PMIS) manual is also an agent facilitating HCWs' understanding and purpose of pharmaceutical indicators, their description, data collection and analysis methodology. Standard Treatment Guidelines (STGs) are an equally important agent as they guide rational prescribing of medicines. The national-level managers will oversee the non–human resource agents for their contribution in the model.

The recipients. These are the target users of the model, in this case prescribers and pharmacy staff. These cadres are key players in enhancing data quality and utility, by the fact that they serve patients and handle medicines or other pharmaceutical commodities thus impacting on pharmaceutical services. Recipients also include staff within the
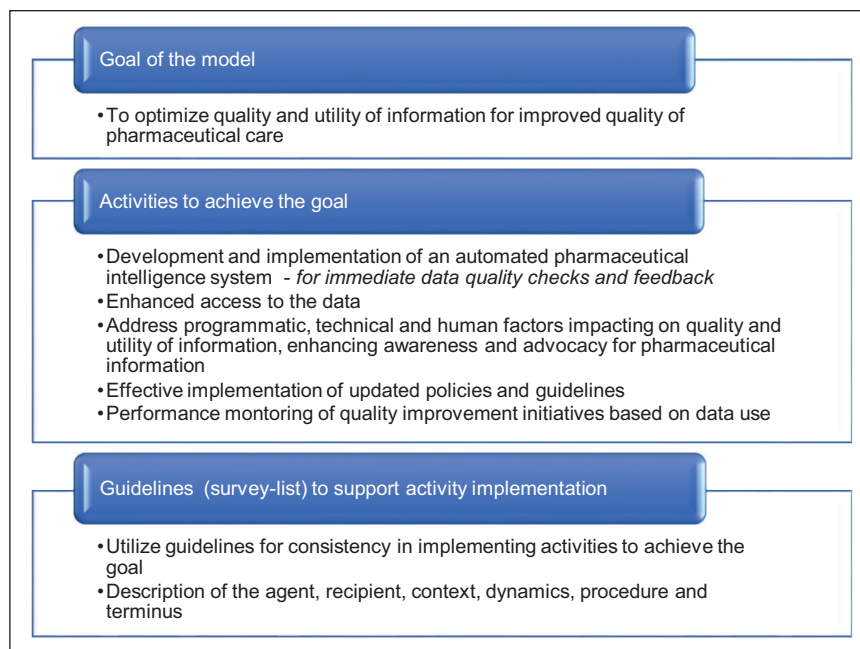
Figure 1. Illustration of the three key ingredients for the model.

MoHSS and public service who are responsible for timely procurement, quality storage, distribution, management, and efficient use of pharmaceutical supplies; recruitment, training, and retention of competent target HCWs to offer quality services.

The context. Activities will be implemented within MoHSS health facilities, districts, regions, and national levels with respect to provision and management of pharmaceutical services for pubic healthcare. Within these structures, the patient is met at the health facility where services are delivered. But to make possible the provision of healthcare, managers plan and oversee implementation of healthcare interventions for the patients; the MoHSS provides financial, human, and pharmaceutical resources for service delivery. Within the MoHSS structures, pharmaceutical policies and guidelines like the STGs, PMIS manual of 2012, pharmaceutical dispensing standard operating procedures (SOPs) of 2014 are developed and implemented. The context thus encompasses both physical factors like health facilities and non-physical factors like relationships among the target HCWs at all levels.

Energy source/dynamics/motivating factors for implementing the activities. Sub-optimal indicators necessitate and drive action to improve quality of healthcare, treatment outcomes, rational medicine metrics as well as prevent AMR.[6,12,21] Besides metrics, HCWs are motivated by restoration of health or fear of loss of jobs due to poor performance,[26] awareness for quality healthcare and conducive environment. This motivation needs to be reinforced/sustained by

training, mentoring and technical support, engagement, supportive management with resources, recognition, and performance rewards.

Procedures for implementing the model in resource-limited settings

The activities are to be implemented by PIS focal staff and managers responsible for pharmaceutical services within MoHSS structures in public healthcare.

Data management (collection, quality assurance, aggregation, and analysis). Pharmacy staff and nurses-in-charge for health facilities will collect PIS data and input into the pharmaceutical intelligence system, guided by the PMIS manual.

Data management, feedback, and access to information. The pharmaceutical intelligence system will support automated data quality checks, aggregation, immediate feedback, and notification of feedback to PIS focal staff and managers. The summary report will show status of the indicator against the target, color-code result, give preliminary decision and an automated short recommendation. The electronic data record makes data easily accessible to users. The managers should retrieve the report, discuss in existing media/forums with target HCWs, facilitate implementation, monitor, and report on actions.

Dissemination/feedback. At national level, the automated system summaries will be consolidated into a comprehensive
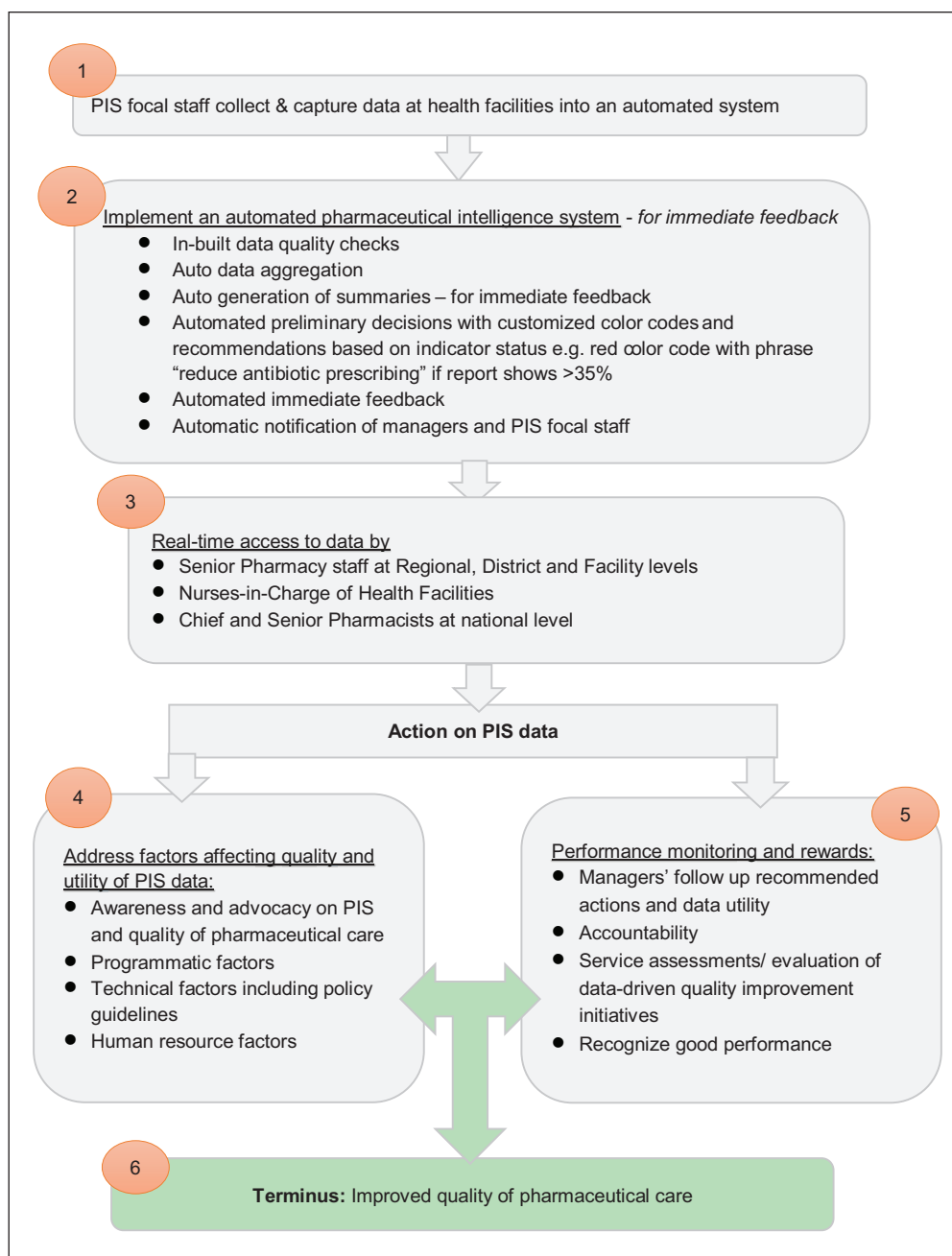
Figure 2. Interlinkages among the concepts and activities in the model.

national feedback report and disseminated at all levels. Managers should ensure feedback reaches all the target HCWs, support implementation of recommendations, and account for performance on pharmaceutical services.

Technical support for PIS feedback/dissemination and utility. MoHSS managers in charge of pharmaceutical services at national/regional/district levels support capacity enhancement of HCWs through pharmaceutical-related trainings, mentoring, providing updated NSTGs, pharmacy dispensing SOPs, and PMIS manual with set targets.

This prescribed procedure within existing MoHSS structures will ease integration, clarify activities with guiding policies and efficient implementation.

Terminus (outcome/goal)

The ultimate goal is improved quality of pharmaceutical care and better health outcomes expected to result from enhanced quality and utility of information. Enhanced utility of information is considered at >80% of target managers using the information. Quality care entails availability

Table 2. Model activities for implementation to enhance utility of quality PIS data..

Activity and the implementation
Activity 1: Collecting quality data: Collecting quality data is addressed by the automated pharmaceutical intelligence system with in-built data quality checks. Data collection from manual and electronic systems is guided by the PMIS manual.[29] Agents and recipients of the model collect data within public health facilities.
Activity 2: Implementing an automated pharmaceutical intelligence system: This component draws from the PIS data quality study and PIS data utility study that showed a desire for more timely, quality, and useful feedback on PIS data.[12,15,22] The system should have in-built data quality checks to ensure complete and consistent data; auto-aggregate data immediately data entry is completed; auto-generate summaries; provide preliminary automated decisions and recommendations, and immediately notify target HCWs and managers of feedback. Automated decisions can include color codes in the report and recommendations based on status versus target, for example, red highlight if antibiotic prescribing is above MoHSS threshold >35%; and a basic recommendation to "review/reduce antibiotic prescribing." The system facilitates real-time access to information for target users.
Activity 3: Advocating for and creating awareness: Advocating for and creating awareness on PIS, the components of which include data collection, quality assurance, data analysis, summarizing and disseminating findings, acting on recommendations to improve quality of care. Quality care is key in improving treatment outcomes, saving costs on healthcare and the burden of disease, preventing adverse events and AMR attributed to irrational prescribing/medicine use.[22,15,32–34] Awareness may be done through existing media/forums like online meetings, continuing professional development sessions, support supervisory visits, therapeutics committee and staff meetings, emails, and annual pharmacists' and doctors' forums[15] targeting prescribers and pharmacy staff. Increased awareness enriches knowledge, interest, and commitment to the purpose of an intervention.
Activity 4: Addressing programmatic factors that impact on data utility: The factors include actively engaging target HCWs; providing quality feedback; enhancing structures for discussion; providing structured support on PIS; providing resources for action on PIS recommendations; communication; setting targets and monitoring compliance toward set targets in the NSTGs and PMIS manual.[29] The agents and recipients will address these factors. Target HCWs should be engaged through sharing comprehensive, timely and clear feedback on PIS, consulting on their understanding, input and motivating their commitment toward improving pharmaceutical care in existing structures/forums. Structured support on PIS entails managers at all levels supporting HCWs/facilities within their jurisdiction on aspects of quality pharmaceutical care through customized capacity enhancement. Resources for action on PIS recommendations include financial, commodity and human resources, up-to-date policy guidelines, and internet to facilitate sharing of information or access to online real-time data, for example, on the MoHSS Pharmaceutical Information Dashboard.[15] Communication should be both verbal and written, formal and informal where managers and PIS focal staff engage prescribers (key players) in rational prescribing/medicine use and pharmaceutical services.
Activity 5: Addressing technical factors including policy guidelines, structured and monitored capacity building of target HCWs, providing up-to-date PMIS manual and templates, pharmacy dispensing SOPs and NSTGs well-aligned with medicine use indicators; and effective implementation of updated NSTGs.
Activity 6: Addressing human resource factors that impact on quality of care and monitoring service delivery. Human resources (pharmacists) impact on PIS data quality.[12,15] The MoHSS should recruit an appropriate staff-mix considering age, sex, length of work experience, duration in post, education level of the PIS focal staff and managers expected to use or spearhead utility of information for service quality improvement; appropriately manage staff workload, recognize staff based on performance and facilitate team work among agents and recipients for increased utility of PIS data.[15]
Activity 7: Performance monitoring, follow-up, and accountability of performance through feedback and action on PIS influences PIS data utility. Managers at facility/district/regional and national levels should act on recommendations to motivate staff to continue collecting and using data.[15] These actions on data should then be reported on in the next reporting cycle.

PIS: pharmaceutical information system; AMR: antimicrobial resistance; PMIS: Pharmaceutical Management Information System; HCWs: healthcare workers; NSTGs: National Standard Treatment Guidelines; SOPs: standard operating procedures.

of medicines, rational prescribing/use of medicines supported by quality NSTGs, sufficient numbers of pharmacy staff, physicians and nurses with the appropriate technical expertise, attitude and commitment and in sufficient numbers to serve patients timely and in a quality manner as set out in the pharmacy dispensing SOPs, NSTGs, and PMIS targets. The outcome is expected while holding the following assumptions.

Assumptions of the model

The economy will remain favorable for procurement of enough medicines; recruitment of target HCWs for quality pharmaceutical services; and continuous technical support for quality pharmaceutical care. Medicine use policies (STGs, PMIS manual) will be updated regularly to meet requirements for quality services and performance monitoring. A relatively stable motivated workforce for pharmaceutical services and management will be maintained. HCWs are committed to continuous quality improvement for better outcomes of healthcare.

Experts' evaluation of the model

Six pharmaceutical/public health experts evaluated and validated the model on clarity, simplicity, generality, applicability, and importance aspects adapted from Chinn and Jacobs.[27] They commended the model as clear; simplified
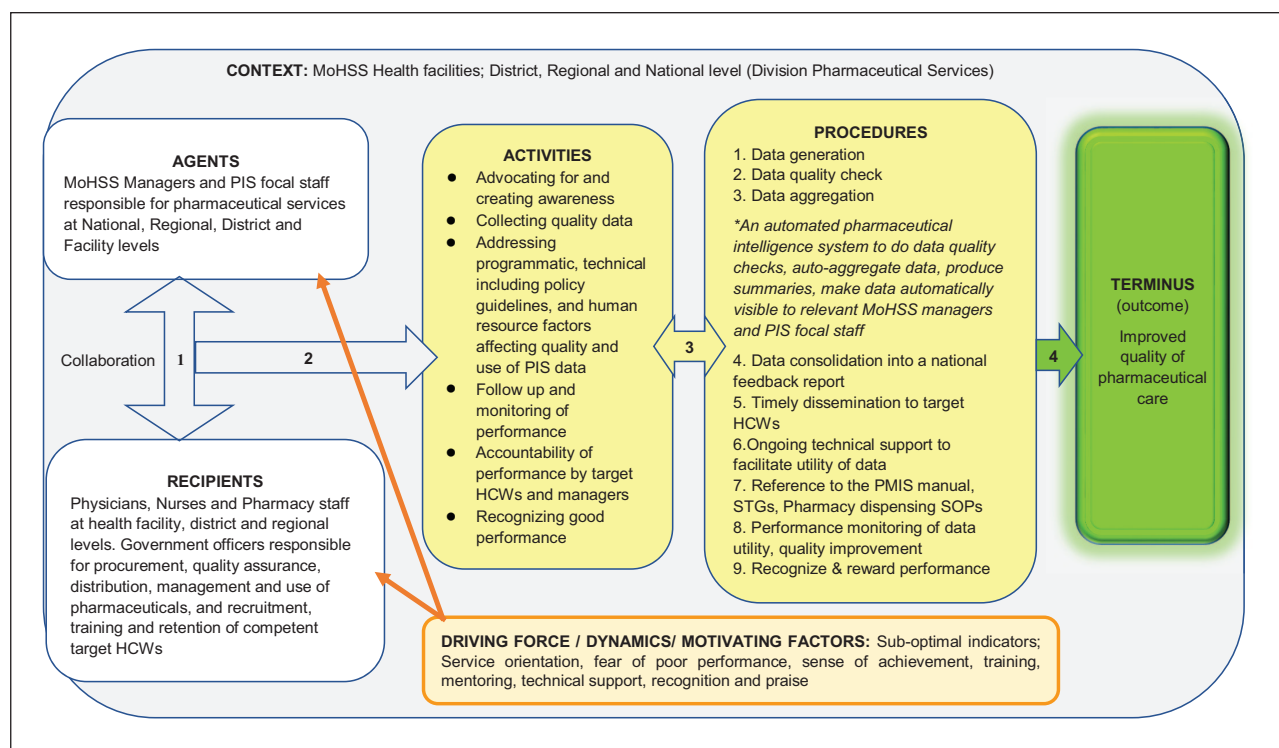
Figure 3. The model for optimizing quality and utility of information for improving pharmaceutical care.

and easy to understand; general in scope to cover the key elements of a pharmaceutical system and adaptable to suit whatever configuration of a pharmaceutical system; the goal is specific enough to guide the intended users (agents and recipients); it is relevant because it is evidence-based and will help to address the critical area in improving the quality and utility of pharmaceutical indicators. The model is very important for enhancing quality and utility of information for improving pharmaceutical care. Two experts stated,

> "The model has great utility in improving the conceptualization of the entire process of pharmaceutical indicator data collection; data quality assurance; analysis; presentation and feedback. The suggestion of an automated pharmaceutical intelligence system for quality checks, consolidation and immediate feedback is particularly novel."

> "The model can be adopted for the wider health system."

The model can be accessed and used by target users. The infographic form and detailed guidelines are easily adaptable for implementation.

Discussion

We believe that this is the first study to develop systematical model approaches to strengthen the quality and utility of PIS data in a sub-Saharan Africa, given concerns of high disease burden, irrational medicine use, and persistently poor pharmaceutical metrics in the region.[33,34] The model, once implemented has potential to improve surveillance of medicine use at three levels, public health facility, regional/district, and national.[22,25]

First, the authors describe a robust model that integrates findings from a national PIS database implemented over 12 years, 2007–2019, and four nationwide surveys as well as expert opinions from the pharmaceutical and public health sectors. In addition, construction of the model integrated input from a wide range of PIS focal persons at three levels, that is, facility, district/region, and national. Previous studies have modeled HMIS, some using different approaches to the current study, and may not be directly comparable. For instance, Aqil et al. proposed a framework to strengthen HMIS for promoting a culture of information, but did not develop guidelines to enhance utility of the information generated.[35] Similarly, a model developed by Muhindo and Joloba[10] focused on timeliness of HMIS data collection and reporting and using data as a strategy to support timely and reliable reporting. They recommend designing interventions to guide how data are utilized at all levels within the institution. This article presents a more comprehensive model for strengthening PIS and integrates a wide range of evidence on current status and drivers of quality and utility of data.

Encouragingly, opinion experts appraised the model as novel, given that it identifies the need for pharmaceutical

intelligence systems at grass-root level to enhance quality and utility of PIS data. To-date, there have not been studies that qualitatively model PIS in resource-limited settings especially sub-Saharan Africa where the misuse of medicines is greatest. Experts rated the model highly, indicating its applicability and importance in addressing quality of pharmaceutical care, particularly with implementation of the pharmaceutical intelligence system. The model assesses several tiers of a health system in a resource-limited setting, has a high potential for applicability and impact on health outcomes given the role medicines play in the control and treatment of diseases. Second, implementation guidelines for implementation of the concepts at point of care relate to the real situation in a public health facility in a resource-limited setting.

Limitations

We are aware of the limitations with this study. The main limitation is that the study was carried out in one resource-limited country, Namibia and in the public sector among limited PIS focal persons. However, we believe the findings are robust, given that the model was informed by four nationwide surveys, expert opinions and involved all tiers of the public healthcare system in a resource-limited setting. As a result, it provides future guidance for strengthening utility of quality PIS data in resource-limited settings.

Conclusion

While the quality and utility of PIS data is typically suboptimal in resource-limited settings such as Namibia, it is encouraging that a robust model with wide application could improve medicine use and management at all tiers of healthcare systems in resource-limited settings. PIS managers and focus persons in resource-limited settings should integrate activities proposed in the model to enhance the utility of quality data to improve outcomes.

Author contributions

K.H.R. conceptualized the study, developed the model and guidelines with support from M.K.H. and R.W.T.; M.K.H. facilitated external review of the model by six experts in pharmacy and public health fields; K.H.R. developed the model and guidelines, and compiled the manuscript; K.D., M.K.H., and R.W.T. appraised the four preliminary studies that informed the development of this model as well as this manuscript through the various stages of its development for publication. All authors approved submission of the manuscript for publication.

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