



Strathprints Institutional Repository

Kasambara, Ansley Samuel and Kumwenda, Save and Kalulu, Khumbo and Lungu, Kingsley and Morse, Tracy and Beattie, Tara and Masangwi, Salule Joseph and Ferguson, Neil (2014) *Problems associated with the health management information system at district level in southern Malawi*. Malawi Medical Journal : the Journal of Medical Association of Malawi. ISSN 1995-7262 (Submitted)

Strathprints is designed to allow users to access the research output of the University of Strathclyde. Copyright © and Moral Rights for the papers on this site are retained by the individual authors and/or other copyright owners. You may not engage in further distribution of the material for any profitmaking activities or any commercial gain. You may freely distribute both the url (<http://strathprints.strath.ac.uk/>) and the content of this paper for research or study, educational, or not-for-profit purposes without prior permission or charge.

Any correspondence concerning this service should be sent to Strathprints administrator: <mailto:strathprints@strath.ac.uk>

**PROBLEMS ASSOCIATED WITH THE HEALTH MANAGEMENT INFORMATION
SYSTEM AT DISTRICT LEVEL IN SOUTHERN MALAWI**

Ansley Kasambara^{1,2}, Save Kumwenda³, Khumbo Kalulu³, Kingsley Lungu³, Tracy Morse^{1,3},
Tara Beattie¹, Salule Masangwi², Neil Ferguson¹

¹Department of Civil and Environmental Engineering, University of Strathclyde

²Department of Mathematics and Statistics, University of Malawi, The Polytechnic.

³Department of Environmental Health, University of Malawi, The Polytechnic.

Phone: +265(0)999-221-817, E-mail: akasambara@poly.ac.mw, akasambara@gmail.com

Abstract

Introduction

Malawi implemented a Health Management Information System (HMIS) in 1999 whose aim was to improve health data management. However, there still exists a deficiency of accurate, reliable and timely health data to inform effective planning and resource management.

Methods

A cross sectional survey was conducted where qualitative and quantitative data was collected through in-depth interviews, documentation review and focus group discussions. Study participants comprised of 10 HMIS Officers and 10 District Health Managers, from 10 districts in the southern region of Malawi. The study was conducted from March to April 2012 and the data collected was transcribed to identify theme and key points.

Results

The study established that 1 out of 10 HMIS Officers was qualified for the post using Ministry of Health HMIS minimum requirements. The HMIS Officers stated that data collectors for HMIS from the district hospital, health facilities and the community included Medical Assistants, Nurses/Midwives, Statistical Clerks and Health Surveillance Assistants. Challenges with the system included inadequate resources, knowledge gaps, inadequacy of staff and lack of training and refresher courses which lead to information provided not being reliable. The HMIS Officers further commented that missing values arose from incomplete registers and data gaps. Furthermore, improper comprehension of some terms by Health Surveillance Assistants (HSAs) and Statistical Clerks led to incorrectly recorded data. The study suggests that collection of data by a wide range of health workers and use of different tools leads to inaccuracy of the data being reported. Nevertheless, data users reported that they find the system useful for development of District Implementation Plans (DIPs).

Conclusion

There is need for the review of HMIS indicators and harmonization of data collection tools feeding into the HMIS to reduce data inconsistencies. We suggest that Ministry of Health should

consider employing HMIS Officers with suitable qualification as stated under the job requirement, and quarterly refresher courses should be organized to increase the competence of staff involved in data management at all levels.

Keywords: Data management, District Health Office, Health Surveillance Assistant, Statistical Clerk, Challenges and Malawi

Introduction

Reports that are accurate, relevant and up-to-date are required by District Health Offices (DHO) and Ministry of Health (MoH) so that they can monitor the health status of the population, the provision of services as to the coverage and utility, drugs stocks and consumption patterns, equipment status and availability, finances, and personnel on a regular basis [1]. The production of timely and accurate information from various sources is important to health service managers if they are to recognize weakness in health service provision and take actions that will improve service delivery. It was stated that a Health Management Information System (HMIS) is a process whereby health data (input) are recorded, stored, retrieved and processed for decision-making (output) [1]. Decision making broadly includes managerial aspects such as the planning, organizing and control of health care facilities at the national, state and institution levels and clinical aspects which can look into providing optimal patient care.

The HMIS in Malawi lacks reliable, accurate data and this is compounded by inadequate use of available information in planning and management of health services [2,3] . In 1999, Malawi began strengthening the health management information system with analysis of strengths and weaknesses of existing information systems and sharing findings with all stakeholders [3]. They identified a need for reformation of various vertical programme specific information systems into a comprehensive, integrated, decentralized, and action oriented simple system. The first step was conceptualization to digital form, from the old paper system which was not easy to use and produce reports [3]. In 2002, the new Health Management Information System was adopted for use nationwide (Figure 1) [2]. Despite the system now being in place for over 10 years, the system still has data and information challenges which can be attributed to a number of factors.

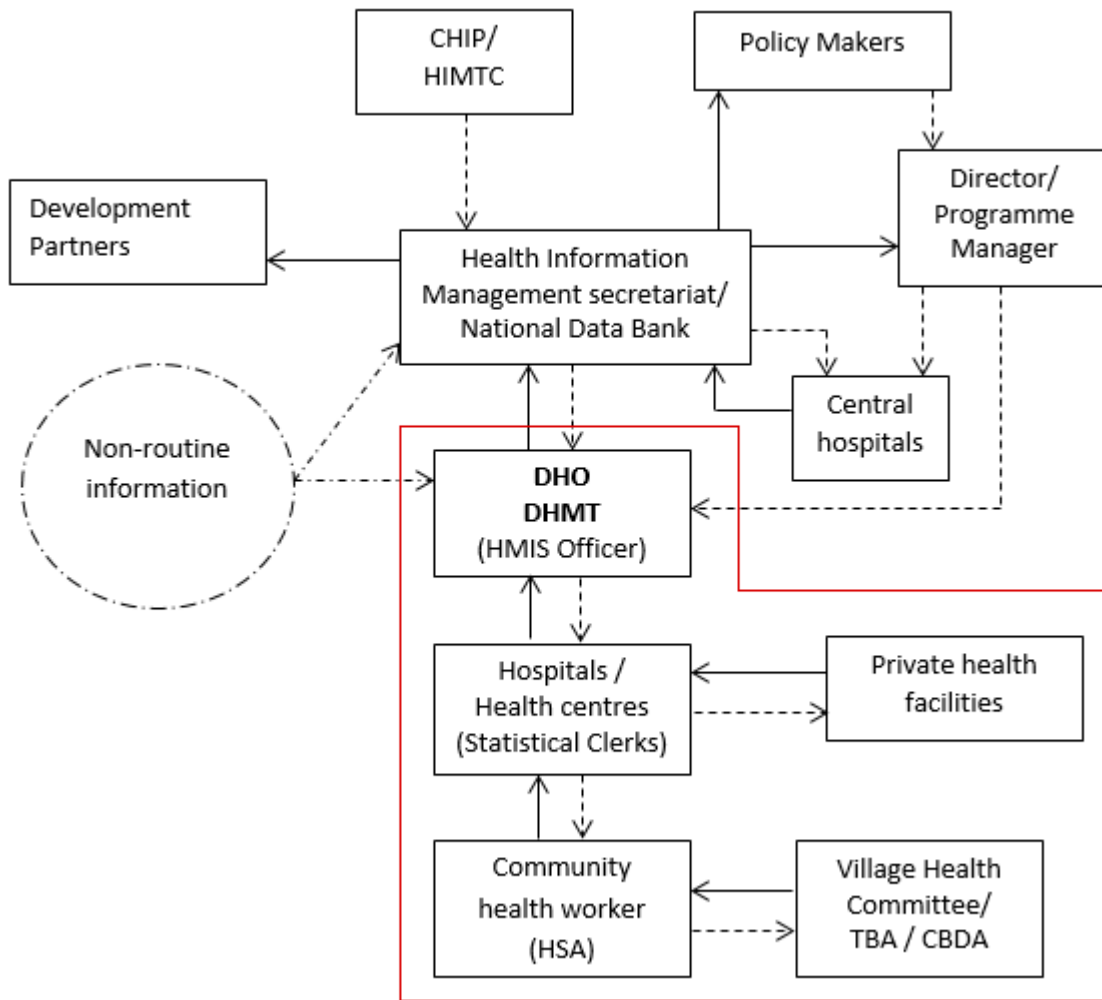


Figure 1: adapted from Channels of Information Flow in the Health Sector [4].

CHIP = Committee for Health Information Policy

HIMTC = Health Information Management Technical Committee

DHO = District Health Office

DHMT = District Health Management Team

TBA = Traditional Birth Attendant

CBDA = Community-Based Distribution Agent

Using maternal health as an example, a number of factors have been documented as contributing to poor HMIS. One major problem has been production of proper reports so that progress can be followed and short falls identified, and despite the large concentration on interventions to improve maternal health, data and reports produced (if any) to demonstrate impact are limited

[5–7]. These reports are also affected by missing, and poorly recorded information [8,9]. Missing information on maternal health from the records compiled by Health Surveillance Assistants (HSAs) has been attributed to a number of factors such as lack of knowledge on how to report causes of death and who to report to on the deaths that occurred. The study also reported that some deaths occurred in the care of Traditional Birth Attendants (TBA) and these deaths were only reported to traditional leaders while some deaths were not reported at all [9]. In 2007 the Government of Malawi directed that TBAs should no longer conduct deliveries in rural areas [10]. However, many TBAs still conduct deliveries and when there are complications they do not report to government or health centre officials for fear of reprisals [10]. It can therefore be assumed, that estimates of data reported at district hospitals may not reflect the actual situation in the rural communities. Thus the database of information for Malawi and sub-Saharan Africa, potentially contains limited and defective data [11–13] .

A lack of comprehensive information which would influence formulation of policy, allocation of resources, and track progress affects the day to day running of the health services in Malawi. Lack of credible information may also affect the support of non-governmental organisations (NGOs) and multilateral donors, who may not support or withdraw support from the sector as the impact of their interventions cannot be measured because accurate and reliable reports cannot be produced. This would in-turn affect the less privileged in the communities.

This study was carried out from March to April 2012 in the southern region of Malawi. It investigated the barriers to effective management of health data at district level, focusing on the data management, human capacity in HMIS and data use.

Methodology

Research design

The study was a cross sectional survey which collected qualitative and quantitative data from HMIS Officers and District data users. The main focus of the study was the data management process (generation, analysis, storage and retrieval), human capacity within the HMIS and use of HMIS data to develop tangible reports to make decisions that effectively allocate resources and in the long term influence policy. The study collected data on the qualification of the data

custodians at district health offices, length of service, sources of data, accuracy and reliability of the data, report from the system, objectives of the system and suggestions on how to improve the data collection process and the system in order to get better output.

Population and sampling

Of the 13 districts in the southern region, 10 agreed to participate in the study. Therefore data was collected from 10 HMIS Officers and 10 District data users (District Environmental Health Officers (DEHO) (n=7); Programme Coordinators (n=3)). The HMIS Officers and data users were sampled from Blantyre, Mulanje, Chikhwawa, Chiradzulu, Mwanza, Thyolo, Balaka, Zomba, Phalombe and Machinga districts.

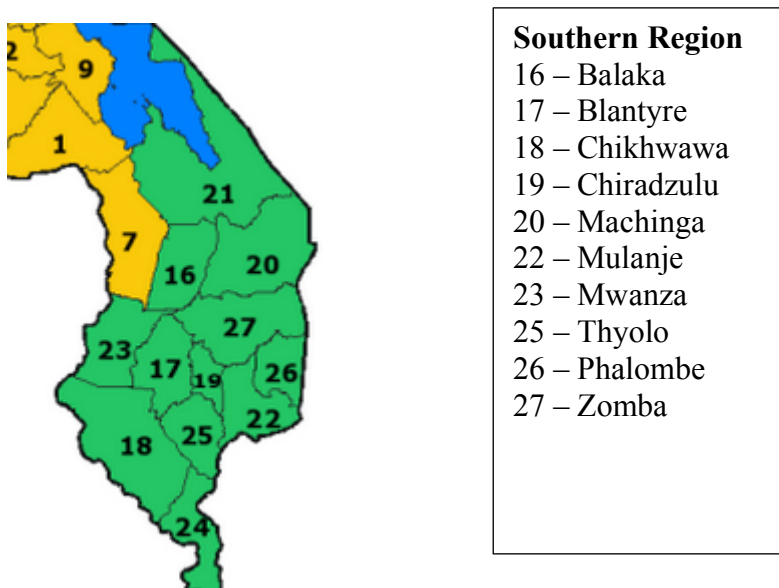


Figure 1: Map of the Southern region of Malawi outlining the participating districts [14]

Data collection and analysis

A combination of face to face interviews (digitally recorded and transcribed) and self-administered questionnaires were used to collect data from HMIS Officers and District data users using pre-tested tools. Copies of HMIS data collection tools were acquired from respondents and responses to interview questions were summarized. Themes were derived from information within interview transcripts and questionnaire data. Frequency tables were developed for the

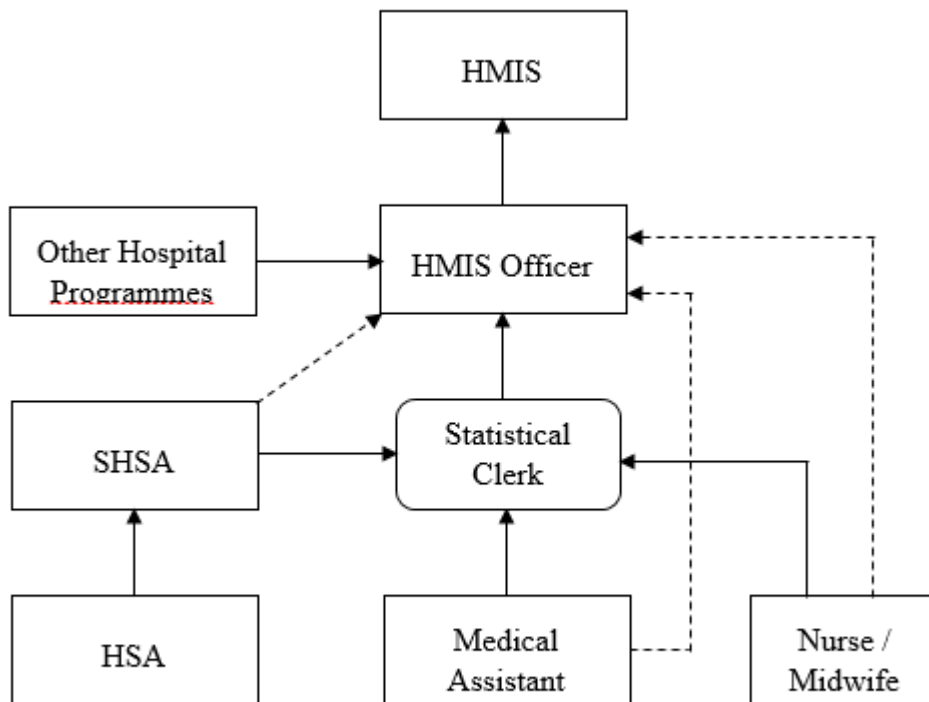
sources of data and challenges met by these sources of data as perceived by HMIS Officer and District Data Users. Data collectors' reliability was rated by HMIS Officers on a scale of one to ten, with one being unreliable and ten being very reliable. The overall reliability was arrived at by calculating the average.

Results

Data management

The study found that data for the HMIS was generated by a number of data collectors as presented in Figure 2 below.

Figure 2: Data flow process as described by HMIS Officers.



Key:

—> = Theoretical data flow

- -> = Actual data flow

HSA = Health Surveillance Assistant

SHSA = Senior Health Surveillance Assistant

HMIS = Health Management Information System

HMIS respondents indicated that the primary data collectors are HSAs, Midwives/Nurses and Medical Assistants. They also indicated that these data collectors were getting information at different levels and using different registers and forms. For instance HSAs provide data from the communities whereas the Midwives/Nurses and Medical Assistant provide data at the health facility level. Table 1 shows the responses obtained when the HMIS Officers were asked to outline the sources of data for the system.

Table 1: Data Collectors as mentioned by the HMIS Officers

Data Collector	Number of HMIS Officers who mentioned source
Health Surveillance Assistance	10
Statistical Clerks / Ward Clerks	10
Medical Assistants / Clinical Officers	6
Nurses / Midwives	4
Safe Motherhood Coordinator	2

The HMIS Officers stated that data has to flow from data collectors (HSAs through a SHSA, Medical Assistant and Nurses/ Midwives) to the Statistical Clerks every month. The Statistical Clerks compile quarterly data on to Form 15 which is used by the HMIS Officer to enter data into the system. Other Hospital programmes (i.e. Safe Motherhood Programme, Community-Based Maternal and Health, Under Five) also feed data into HMIS through the HMIS Officer. However since Statistical Clerks are not available in most health facilities and hospitals, the data collectors send their data separately through the HMIS Officer. HMIS Officers indicated that after data generation, data should be sent to the Statistical Clerk for compilation to a standard HMIS data form (Form 15), which is then sent to HMIS office at the District hospital (Figure 2). Data collectors should submit their data monthly and the data is compiled and forwarded to the HMIS office quarterly. Data from HSAs is compiled by a Senior Health Surveillance Assistant (SHSA) based at the health facility whereas Medical Personnel compile their own data. Most health facilities do not have a statistical clerk and as such data goes straight to the HMIS Office. The

data is entered into the system by either the HMIS Officer or Senior Statistical Clerk, who is supposed to be a statistician by profession, at the District Health Office.

The challenges faced by the HMIS in terms of data management were outlined as:

- The registers used to collect data by health workers (HSAs), have more indicators than those contained in the standard HMIS form (Form 15) used by Statistical Clerks. As such, the data transferred for submission to HMIS Office is less than the generated data being captured in the system.
- HMIS Officers indicated that discrepancies exist in the data, as different data collectors generate data using different tools. This was verified by examining and comparing the data collection tools for HSAs, Health Facility Personnel, Programme Coordinators which were found to define indicators differently. This led to differences in interpretation of the indicators by the different personnel.
- The other cause of discrepancies is the inability of the system to consolidate data from the different data collectors to eliminate duplication, reduce data loss and handle referrals. This was reported as a common problem, for example records of the same patient submitted by an HSA and Health Facility Personnel may be duplicated in HMIS as two different patients.
- Untimely submission of reports, inconsistency of data and misplaced or, fabricated data, are discrepancies which are usually encountered when compiling monthly reports to quarterly reports. This untimely submission can be attributed to various factors. For example, health facilities in remote rural areas, find it difficult for data collectors such as HSAs to send their data to Senior HSAs to compile and subsequently send their data to the HMIS office in a timely manner due to logistical constraints. Inadequate resources in terms of transport to collect data from the field to the Health Facility and eventually to the District Health Office also contributes to the delays in compiling of the data in the system.
- Power failure and faulty computers at District level which take long to be repaired by the Ministry.
- Currently districts are creating their own databases to collate data as such they are not harmonized which can lead to discrepancies. One HMIS Officer stated “*databases are different between the districts and they need to be harmonized*”.

Table 2: Challenges faced by data collectors as perceived by HMIS Officer

Challenge	HSA s	Statistical Clerks	Medical Assistants	Nurses	Total
Inadequate resources (Transportation, Registers and Health Passports)	6	4	1	1	12 ¹
Knowledge gaps (for HSAs and Statistical Clerks)	4	4	1	1	10
Inadequacy of staff (HSA, statistical clerks, Clinical officers and Nurses)	4	3	0	1	8
Lack of training, refreshers and review meetings	9	4	0	1	14 ¹
Pressure of Work	3	0	2	3	8

- Inadequate personnel at health facilities lead to a number of pressures on few people, including the collation of accurate HMIS data. Due to a lack of statistical clerks at health facilities, the responsibility for data collection often lies with clinical staff such as nurses and medical assistants. As they are already overburdened with the number of patients they must attend to, HMIS work can be seen as secondary to their curative duties.
- HMIS officers further stated that there is usually a delay in data from the different vertical programmes (i.e. Safe Motherhood Programme), which provides a challenge in production of reports. In terms of safe motherhood, HMIS officers also indicated a concern that figures may be inflated for purposes of receiving more medication to a facility thereby affecting the planning system and resource management.

Other issues leading to challenges with HMIS objectives were related to human capacity within the system and included:

- Lack of training, refreshers and review meetings was mentioned 14 times by different HMIS Officers for the different data collectors. The need for refresher courses was evidenced in their low educational level and hence differences in understanding of indicators. This

deficiency leads to other challenges such as inconsistent data and data gaps, which are a result of knowledge gaps among the data collectors.

- For HSAs, Statistical Clerks and Ward Clerks, lack of training is a problem since they find difficulties in using the data collection tools. HMIS Officers suggested that this could be due to their level of education hence the need for training supplemented by constant supervision to develop competency.

Human capacity within HMIS

Qualification of the HMIS Officers

The Ministry of Health (MoH) states that the minimum qualification for an HMIS officer is either a Bachelor of Science in Information Technology (IT), Information Systems (IS) or Computer Science (CS) [4]. However, the qualifications of these HMIS officers ranged from Malawi School Certificate of Education to a post graduate diploma in Development Economics. Table 3 shows the qualifications of the HMIS Officers at the time of interview.

Table 3: HMIS Officers Qualifications

Qualification	Number Qualified
MSc in Biostatistics	1
BSc. In IT, IS or CS	0
Diploma in Information Systems Management	1
Diploma in Statistics	2
Advanced Certificate in Statistics	1
Certificate in Statistics	3
<i>Malawi School Certificate of Education</i>	2

Eight HMIS Officers interviewed were qualified statisticians with minimum of a certificate in statistics, two were found to only have a Malawi School Certificate of Education with no specific statistical training. Competency through experience was not assessed in this study. Overall, 9 of the HMIS Officers did not meet the MoH minimum requirements of having a Bachelor's degree, however those who responded had an average of about 5 years' experience on the position of HMIS Officer.

Understanding of the HMIS objectives by HMIS Officers

The objectives of the system are to collect, compile, analyze data and disseminate information and ensure that the data is complete and consistent [3]. The system analyses the data to check health indicators and production of reports in appropriate time to enable decision makers or managers to plan accordingly. This further enables monitoring and evaluation of the health systems' progress. All HMIS Officers were able to state the objectives of HMIS (Box 1)

The HMIS Officers stated that HMIS was on average achieving 88% of its objectives. The reasons HMIS not achieving 100% were delays in receiving data, corrupted files and software, lack of training, and lack of interaction between departments. For example,

HMIS indicated poor data sharing between their office and the Safe Motherhood Programme. It was felt that programme planning and decisions were made without reference to HMIS data, as they had collated their own statistics, and data collected by the two sections was also reported as inconsistent.

Data use

Data Use According to HMIS Officers

HMIS Officers indicated that data should be used for a number of purposes including registration of patients which enables District Data Users to determine the use and potential overloads at different health facilities. All HMIS Officers stated that data provides information which should help decision makers plan different activities. Furthermore, the information helps to check indicators by production of reports in the form of graphs to different programme coordinators i.e. the Community-Based Maternal and Neonatal Health Coordinator and Safe Motherhood Coordinator. However, it was mentioned that data from the system is not fully utilized therefore

Box 1 – The objective of HMIS as stated by the HMIS Officers

“to analyze and check health indicators”

“to collecting data, processing data and analysis of data to check health indicators”

“to ensure completeness, consistency and timely reporting”

“for decision making – monitoring and evaluation”

“Collection, compilation, analysis and dissemination of health data for planning purposes”

HMIS is not used to its full potential. As such programme planning and human resource / drug distribution did not fully utilize HMIS data in decision making. As a result some departments overestimate figures for drugs required based on their own estimates, stated an HMIS Officer.

HMIS Officers were asked to give their interpretation of data collector’s reliability. Reliability is referred to as the “the extent to which we can rely on the source of data and therefore the data itself” [15,16]. Reliability was measured on a scale of 1 to 10 (1=not reliable, 10=very reliable) and an average reliability was calculated for every data collector. (Table 4)

Table 4: HMIS Perceptions of Data Collectors Reliability

Data Collector	Estimated Average Data Reliability
Nurses / Midwives	9.5
Statistical Clerks / Ward Clerks	9.2
Health Surveillance Assistance	8.2
Medical Assistants / Clinical Officers	8
Safe Motherhood Coordinator	8

HMIS Officers stated that data from Nurses/ midwives has an average reliability of 95%, seconded by data from statistical clerks with an average reliability of 92% despite the lack of personnel at health facilities. Statistical clerks and nurses / midwives were scarce in health facilities which may have led to shortfalls in data reliability.

Accuracy can be defined as the degree of correctness [17], or the degree of measure to a standard or a true value [18]. Responding to the question of accuracy of the data from different data collectors, 8 out of 10 HMIS Officers said that the data was on average 85% accurate, and the remaining two officers were neutral. The lack of accuracy was attributed to a number of factors including (1) completeness of data as there are missing values from registers, (2) lack of training of data collectors with one HMIS Officer stating that, “*Comprehension of some terms by the statistical clerks or HSA who is compiling the data*” was another factor that leads to inaccurate

data, and (3) private clinics do not submit data to the HMIS office leaving a gap in data from health services provided. This means that there are shortfalls in data collection procedures as well as adherence to proper channels of data collection. If HMIS Officers doubt the accuracy of the data, they are supposed to go and verify if the data is correct

Adequacy of Data for Making Plans and Decisions as District Data Users

According to 3 District data users, the data from HMIS is not comprehensive or adequate for effective planning and decision making due to the limited number of indicators for their specific programmes. However District Data Users felt this type of data is very useful for general monitoring of service delivery, policy development and high level planning. Four out of ten said as District Data Users, information was adequate for their specific programmes because it allows them to monitor trends on health service delivery and disease prevalence. Despite the data being inadequate, two district data users claimed that various plans and decisions were being made depending on HMIS data report which is circulated quarterly. These include: creation of district health strategic plans, district annual implementation plans, departmental plans, to guide partners in the district on program/project planning, immunization plans, development of the ICEIDA/DHO Public health programme document, disease outbreak response,

Adequacy of indicators in HMIS

Some respondents stated that the indicators are not exhaustive for all activities. Each health program requires a certain number of indicators for monitoring and evaluation hence need for specific program data collection. For example in Water, Sanitation and Hygiene (WASH), HMIS only captures households with an improved sanitary facility. This one indicator cannot be used to fully monitor a WASH program. There is need to revise HMIS indicators to include some essential elements which are currently missing. Though it was noted that HMIS is intended to provide general integrated health data covering a wide range of health problems/conditions and health services, some important indicators need to be considered for inclusion i.e. HIV and AIDS indicators.

Discussion

The study found that there are multiple data collectors getting information at different levels and using different registers and forms. Some vertical programmes still feed data into the HMIS despite the Ministry of Health (MoH) agreement in 1999 with all stakeholders on the need for the reformation of various vertical programme specific information systems into the current integrated HMIS [3]. Furthermore, the study found that verification of results at facility level from the multiple collectors was not being done due to human resource constraints as the Ministry had initially planned to have a position of Assistant Statistician at each facility to authenticate the results before being forwarded to the next level. The MoH recommended quarterly verification of individual records for completeness and accuracy [4]. The HMIS officers interviewed reported that the discrepancies in data collected was as a result of the systems failure to consolidate data from different data collectors to eliminate data duplication and loss. Discrepancies in data collected and reported was also due to the current practice of districts creating their own data bases.

The MoH recognizes that the quality of data that are collected by facilities is poor as it is incomplete and questionable in terms of reliability for programme planning [3]. However, the HMIS perceived data from statistical clerks and nurses/midwives as being more reliable than from the HSAs. This finding is similar to earlier observations by other HMIS surveys conducted in the country [4,19]). The HIMS officers interviewed in this study perceived that data from the systems as neither comprehensive nor adequate for effective plans and decision making due to limited number of indicators for specific programmes.

In order to improve the quality of data collected from all facilities, the Ministry has previously suggested that at least there should be quarterly verification of individual data and monthly data by the District Health Management Team (DHMT) for completeness and accuracy of data before entering in the computer at District Health Office (DHO). Also, there should be at least quarterly follow up and practice based training of each person involved in data recording and aggregation and to ensure accuracy and completeness of data. However, staff interviewed in this survey bemoaned the lack of supportive supervision, training and refresher courses. One possible factor

that may contribute to poor data quality from facilities is lack of facility management to discuss the compiled report before sending it to the next level [19].

The survey revealed that the system is characterized by untimely submission of reports from facility to the district level due to a variety of factors such as remoteness of the facilities and logistical constraints (e.g. transport to collect data from the field). At district level, there are problems of power failure and faulty computers to produce quarterly reports. The Ministry of Health acknowledged the untimely data reporting and lack of support for ICT equipment maintenance at District level [4]. However, this study did not ask how long it takes after data has been collected to compile the report at district and lower levels.

In 2009, the MoH identified a huge deficit in human resources (in terms of quality and quantify) especially at district and facility levels [4]. This study found that none of the existing HMIS Officers in the districts met the minimum qualification for this position. This explains the limited data analysis and use of information in the management of health services at facility and district levels.

Most data users agreed that data quality is questionable. Some data users stated that data was accurate because HMIS data was collected at point of service delivery and there was a system in place where health facility management teams collect data direct from the registers and compile the data in prepared collection HMIS forms. However other users argued that it was not accurate because of differences with the data collected through other parallel systems from same source e.g. Disease Surveillance data and routine immunization data.

Conclusions

The Ministry of Health has been implementing a comprehensive and decentralised routine HMIS country wide since 2002. However, 12 years later, the HMIS is faced with a number of problems which range from use of different tools for data collection, missing data, untimely reporting, human resource constraints, and poor ICT infrastructure at district level. Data management is poor in terms of completeness, consistency and timeliness making the HMIS unreliable for effective programme planning and decision making.

Recommendations

More HSAs, clinical staff and statistical clerks need to be trained in HMIS to ensure accurate data capturing and timely reporting. Forms and registers should always be available to HSAs and Medical personnel to avoid data gaps. The current forms need to be reviewed to address indicators for emerging and non-communicable diseases. The Ministry of Health need to employ HMIS Officers with Bachelor's degrees as stated in the job qualification requirements. We recommend further research on the extent of use of HMIS data for planning by District and Health Centre Managers.

Acknowledgements

The authors wish to acknowledge the following persons; District Environmental Health Officers (DEHO), District Health Officers (DHO) and HMIS Officers who participated in our study for their time during interviews and filling in questionnaires.

References

1. Bodavala R. Evaluation of Health Management Information System in India Need for Computerized Databases in HMIS. Ranganayakulu Bodalava Takami Fellow Int Health Harv Sch Public Health [Internet]. 1998 [cited 2014 Jun 10];665. Available from: <http://folk.uio.no/patrickr/refdoc/teams/Evaluation%20of%20HMIS%20in%20India.pdf>
2. Chaulagai CN, Moyo CM, Koot J, Moyo HBM, Sambakunsi TC, Khunga FM, et al. Design and implementation of a health management information system in Malawi: issues, innovations and results. *Health Policy Plan.* 2005 Nov;20(6):375–84.
3. Ministry of Health. Health Information Systems Assessment Report. Lilongwe, Malawi: Malawi Government; 2003.
4. Ministry of Health. Health Information System Assessment. Lilongwe, Malawi: Malawi Government; 2009.
5. Fauveau V. Effect on mortality of community-based maternity-care programme in rural Bangladesh. *The Lancet.* 1991 Nov;338(8776):1183–6.
6. Ministry of Health. National Reproductive Health Strategy. Lilongwe, Malawi: Malawi Government; 2009.
7. Versalovic J, Lupski JR. Molecular detection and genotyping of pathogens: more accurate and rapid answers. *Trends Microbiol.* 2002;10(10):s15–s21.

8. Graham WJ, Ahmed S, Stanton C, Abou-Zahr CL, Campbell OMR. Measuring maternal mortality: An overview of opportunities and options for developing countries. *BMC Med*. 2008 May 26;6(1):12.
9. Masangwi S. Scotland Chikhwawa Health Initiative Safe Motherhood Project, Chapananga, Chikhwawa District, Malawi. Chikhwawa, Malawi: The Scottish Government; 2010.
10. C K, T M, S M, P M. Barriers to maternal health service use in Chikhwawa, Southern Malawi. *Malawi Med J J Med Assoc Malawi*. 2011 Mar;23(1):1–5.
11. Boerma T. The magnitude of the maternal mortality problem in sub-Saharan Africa. *Soc Sci Med* 1982. 1987;24(6):551–8.
12. Say L, UNICEF, United Nations Population Fund, World Health Organization, Reproductive Health and Research, World Bank. *Maternal mortality in 2005: estimates developed by WHO, UNICEF, UNFPA and the World Bank*. Geneva: World Health Organization; 2008.
13. World Health Organization, UNICEF, United Nations Fund for Population Activities, World Bank. *Trends in maternal mortality: 1990 to 2010 : WHO, UNICEF, UNFPA, and The World Bank estimates* [Internet]. 2012 [cited 2014 Jun 10]. Available from: <http://www.who.int/reproductivehealth/publications/monitoring/9789241503631/en/>
14. Ministry of Health. *Malawi Health Management Information System Bulletin*. Lilongwe, Malawi: Ministry of Health, Planning Department; 2005.
15. Davis CL, Pierce JR, Henderson W, Spencer CD, Tyler C, Langberg R, et al. Assessment of the reliability of data collected for the Department of Veterans Affairs national surgical quality improvement program. *J Am Coll Surg*. 2007 Apr;204(4):550–60.
16. Chapman AD. *Principles of Data Quality*, [Internet]. GBIF Secretariat; 2005 [cited 2014 Jun 10]. Available from: <http://www.gbif.org/resources/2829>
17. Scannapieco M, Catarci T. Data quality under a computer science perspective. *Arch Comput*. 2002;2:1–15.
18. *Managing Information Quality - Increasing the Value of Information in Knowledge-intensive Products* [Internet]. [cited 2014 Jun 10]. Available from: <http://www.springer.com/business+%26+management/business+information+systems/book/978-3-540-31408-0>
19. Moyo C. *An assessment of the quality of health management information system data in selected health facilities in Lilongwe district* [Internet] [Thesis]. [Blantyre, Malawi]: University of Malawi, College of Medicine; 2005 [cited 2014 May 25]. Available from: www.medcol.mw

