Mapping health information system competencies for health workers in low- and middle-income countries

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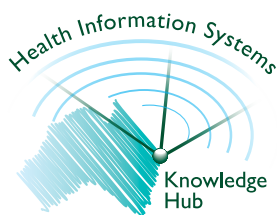**Renata E Mares**

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Knowledge Hub

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Strengthening health systems
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This research has been funded by AusAID. The views represented are not necessarily those of AusAID or the Australian Government.

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Health Information Systems Knowledge Hub

Acronyms and abbreviations

DHMIS   District Health Management Information System

HIS   health information system(s)

HIS Hub   Health Information Systems Knowledge Hub

HMIS   health management information system(s)

HMN   Health Metric Network

HR   human resources

HRH   human resources for health

ICT   information and communication technology

LMICs   low- to middle-income countries

MDG   Millennium Development Goal

PRISM   Performance of Routine Information System Management

RHIS   Routine Health Information System

WHO   World Health Organization

Summary

Key points

- Health information systems are an essential building block of the health system as they provide data and information for a range of purposes and users.
- A workforce skilled in generating, analysing and using data is required; however, in low- to middle- income countries there is a shortage of health information system specialists and a lack of capacity and confidence among the general health workforce to perform health information system tasks.
- For strengthening health information systems, investing in building the capacity of the workforce offers a better return than simply investing in technological solutions. However, it is also the biggest cost driver in health information system strengthening.
- A major issue contributing to the lack of health information system skills among health workers is the absence of defined competencies and a high level of uncertainty around roles and responsibilities as they relate to the health information system.
- For this study, an expert panel compiled and sought to validate a draft framework of health information system competencies for health workers in low- to middle-income countries.
- With further refinement, the framework could be used to inform capacity-building plans for strategically developing health information systems.

Key terms

Health information system

'A set of components and procedures organized with the objective of generating information which will improve health care management decisions at all levels of the health system' (Lippeveld et al. 2000).

'An integrated effort to collect, process, report and use health information and knowledge to influence policy-making, programme action, and research' (WHO 2003).

Competencies

The knowledge, skills, abilities and/or qualifications required to adequately perform specific tasks.

Introduction

Health information systems are a key building block of the health system (WHO, 2007). They are responsible for generating timely and reliable data which is essential for evidence-based health service delivery and management. While there is growing recognition that 'informed decisions are better decisions' (Abusayeed et al. 2010), the sound health information required for decision-making is often unavailable and underused in low- and middle-income countries (LMICs) (Chaulagai et al. 2005; Kimaro & Twaakyondo 2005).

Consensus is lacking about the term 'health information systems', as people's interpretations differ on which types of data systems and sources are relevant to include. For example, some people see a health information system as information generated *by* the health system, such as routine health information systems. Others see a health information system as the data generated *about* the health system by, for example, health management information systems[1]. In this study, a health information system is deemed to encompass both of the aforementioned systems and is defined as, 'a set of components and procedures organized with the objective of generating information which will improve health care management decisions at all levels of the health system' (Lippeveld et al. 2000). WHO (2003) describes a health information system as, 'an integrated effort to collect, process, report and use health information and knowledge to influence policy-making, programme action, and research'. Across the levels of the health system (i.e. primary, secondary and tertiary) and the various service divisions (i.e. public health, clinical services and management systems), health information is required for a variety of purposes such as measuring progress, informing planning, allocating resources, advocating, and management activities. A workforce skilled in collecting, analysing, interpreting, presenting and disseminating health information is essential to fulfil these demands. The human resources—the people who have the knowledge, skills and expertise to make the system work efficiently and effectively—are a key component of health systems. The Health Metrics Network (HMN) is a global partnership which aims to assist countries to improve their health information systems. The HMN states that for a health information system to function effectively it must pay careful attention to, 'the training, deployment, remuneration and career development of human resources at all levels' (WHO 2008). This working paper is centred on human resources, in particular the general health workforce in low- to middle-income countries. We attempt to define and map out the specific health-information-system-related knowledge, skills and abilities (hereafter referred to as 'competencies') that health personnel require at various levels of the health system.

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1 As per the PRISM Framework, routine health information systems and health management information systems refer to any data collected regularly (at least yearly) in health facilities and the communities they serve.

Background

In the 1990s, Lippeveld et al. (2000) promoted the development of routine health information systems (HIS) in low- and middle-income countries (LMICs), with an emphasis on managing the health system. In the decades that followed, however, information systems became increasingly geared towards epidemiological surveillance and performance assessment of donor-funded programs, that is, expanded programs on immunisation, and the initiatives of the Global Fund for AIDS, Tuberculosis and Malaria. This created a series of vertical information systems and a cadre of workers managing information systems who were positioned outside of the health management system. As a result, a division formed between information system professionals (data people) and health systems managers (action people) (Aqil, Lippeveld & Hozumi 2009). Neither group understood the other's roles and responsibilities and the need to work together (Lind & Lind, 2005). More recently, there has been growing recognition that health information systems need to capture, integrate and use both routine health information and data from vertical programs. To this end, personnel in specialised health information system (HIS) roles and general health staff need to work together and recognise that they all have a role in maintaining a functioning health information system.

Shortages in the number of healthcare workers and their unequal distribution across countries and regions is a universal phenomenon (WHO 2006; Cristofari et al. 2009). Many initiatives have been directed at this shortage of human resources for health (HRH). However, they often focused exclusively on rectifying the shortage of skilled workers at the provider/client interface. The role that front-line staff have as primary data generators, recording information on service provision directly (and, ideally, in real time), is too frequently overlooked, as are the implications this has for the health information system. Staff shortages at the facility level exist in the collection, analysis and use of health information; these shortages impact the effective planning and monitoring of patient care, programs and services. Despite recognition that there is a need to develop capacity of human resources for health information systems (Aung & Whittaker 2012; WHO 2008; Braa et al. 2007), few initiatives have focused specifically on building HIS competencies in the general health workforce. This issue was highlighted during the 'Asia Pacific leadership forum on health information systems' in Manila, June 2011 (HIS Forum 2011). There were several discussions about the need to develop HIS training modules for health workers and to define the minimum HIS and information and communication technology (ICT) competencies required by health workers in the modern environment.

For this study, a competency is defined as the 'knowledge, skills, abilities and/or qualifications required to adequately perform specific tasks'. Health information system tasks include paper, or electronic-based functions for data collection (through registries, intake forms, monthly reports etc.), data storage (bookkeeping, filing, shelving etc.), data management (compiling, indexing, organising etc.), and data analysis, reporting and use. Competency-based frameworks are common among health professions in high-income countries and are frequently used to define standards for education and training and for career progression (Hendry, Lauder & Roxburgh 2007). Research shows that competency modelling can identify relevant groupings of knowledge, skills, abilities and other characteristics that affect an individual's role or responsibilities, relate to job performance, are measurable, and are subject to improvement through training and development activities (Lucia & Lepsinger 1999). There is no such framework defining HIS competencies for health workers in LMICs. This framework would define the HIS skills and abilities that the workforce requires at various levels of the health system and enable the education and training sectors to align learning outcomes to these. This would assist individuals and organisations with career planning and allow the health sector to implement useful professional development. In addition, it would provide planners and policymakers with a level of certainty regarding the desired mix and quality of skill sets at various levels of the health system and influence strategies for designing the workforce.

In most professions, competencies are defined within the role or position description, that is, nurses are required to have both theoretical and clinical training in nursing. Competencies can also be described in light of the outputs or products of the health system. For example, a basic output of the health system is a patient medical record which is updated at each visit. The competencies that a nurse might need to complete a medical record include the ability to retrieve the patient's file and take a medical history, and the knowledge and ability to capture this information on standard forms. For other health workers, the competencies required to perform the same task might change in depth and level of specialisation, for example, when a physician consults a patient they may be expected to undertake additional investigations such

as pathology tests, and thus would need to be familiar with standard procedures and tools for documenting this information in the patient's medical record. Competencies around health information can thus be taken from role descriptions and can be generated from descriptions of the health information outputs of the health system. This study takes both forms into account.

The competence of health workers to perform HIS tasks (as measured by a paper-and-pencil test) is a behavioural input of the Performance of Routine Information System Management (PRISM) Framework (Aqil, Lippeveld & Hozumi 2009). The framework describes a 'blind spot' or gap between an individual's perceived and actual competence in performing a specific HIS task (Luft 1969). This reveals that without clearly defined and objectively verifiable competencies the capacity of staff is likely to be lower than expected. The use of competency-based assessment in healthcare training and performance management may partially address this gap. The goal of this research is to create a framework which defines the minimum HIS competencies required by health workers at various levels of the health system. This is described further in the objectives and methodology.

Methodology

The objectives of this study were as follows:

1. Develop a draft framework of HIS competencies for health staff at various levels of the national health system in low- and middle-income countries.
2. Test the validity of the framework concept by consulting experts using an iterative survey.
3. Garner expert feedback on the usefulness of the framework.

We felt that a multi-pronged approach that included a review of the literature followed by consultations with experts was the most suitable way to develop a draft framework of HIS competencies in LMICs. We favoured an iterative approach because it builds upon itself and checks for assumptions at each stage in the process of reaching a final consensus. Figure 1 gives an overview of the research process and following this we provide more detail about each stage.

- Review the literature to assess its availiability and relevance.

- Compile draft competencies and framework structure.
- Identify expert panel.
- Customise round 1 survey tool.

- Conduct round 1 survey.

- Analyse round 1 results and incorporate into round 2 survey tool.

- Conduct round 2 survey.

- Analyse and assess results.

Figure 1 Overview of the research processes

Literature review

The literature review aimed initially to assess the availability and applicability of information to inform the development of: (i) a conceptual framework and methodology for our study and, (ii) the development and validity of a draft framework of HIS competencies.

We conducted a comprehensive search of websites, and grey- and peer-reviewed literature to develop the variables of interest for the framework of HIS competencies. Table 1 lists the key search terms used to review online databases of peer-reviewed journal articles and websites posting government reports related to HIS standards and policies. We applied a snowballing method to the reference lists of all literature to build the bibliography. We used search terms individually and combined in multiple ways using Boolean operators (AND, OR). The initial search yielded 1053 publications and resources, which was reduced to 47 based on the criteria described below. Figure 3 gives an overview of the inclusion/exclusion process for the literature review.

Table 1 List of resources searched and search terms

Type	Search site	Search terms*
Peer-reviewed journal articles (1990–2012)	Google Scholar Science Direct Pub Med CINAHL	HIS and competency building Health information use and competency building HIS and competency training HIS district level staff HIS and clinicians, nurses HRH and HIS
Government reports	Internet search engine (google.com)	HIS standards HIS policy

* Note: HIS – health information system, HRH – human resources for health

Inclusion/exclusion criteria

The search included articles with descriptions of health information systems competencies, skills and knowledge. Although the competencies framework will be aimed at health workers in LIMCs, we also included papers from high-income countries. Further inclusion criteria were: (i) papers/articles in English language, and (ii) published between 1990 and 2012.

Although many LMICs are embracing health informatics, particularly in Africa (e.g. Rwanda, Uganda, Ghana, Nigeria, Mozambique and Ethiopia) and across Asia and the Pacific (notably the Philippines, Cambodia, Vietnam, Malaysia, Bangladesh, Indonesia and Thailand), many LIMCs still use conventional paper-based systems for collecting health information and are unlikely to rely on advanced technologies (e.g. computers). This study thus aimed to capture the basic HIS competencies which could be expected in LMICs that did not have advanced technology. Determining competencies around health informatics at an advanced level is outside the scope of the present study. We therefore excluded papers which defined particularly advanced competencies or competencies which require advanced information communication technologies. In addition, we excluded papers and reports that focused on elements of health information systems but did not discuss the human resources element of the system, as shown in Figure 3 below.
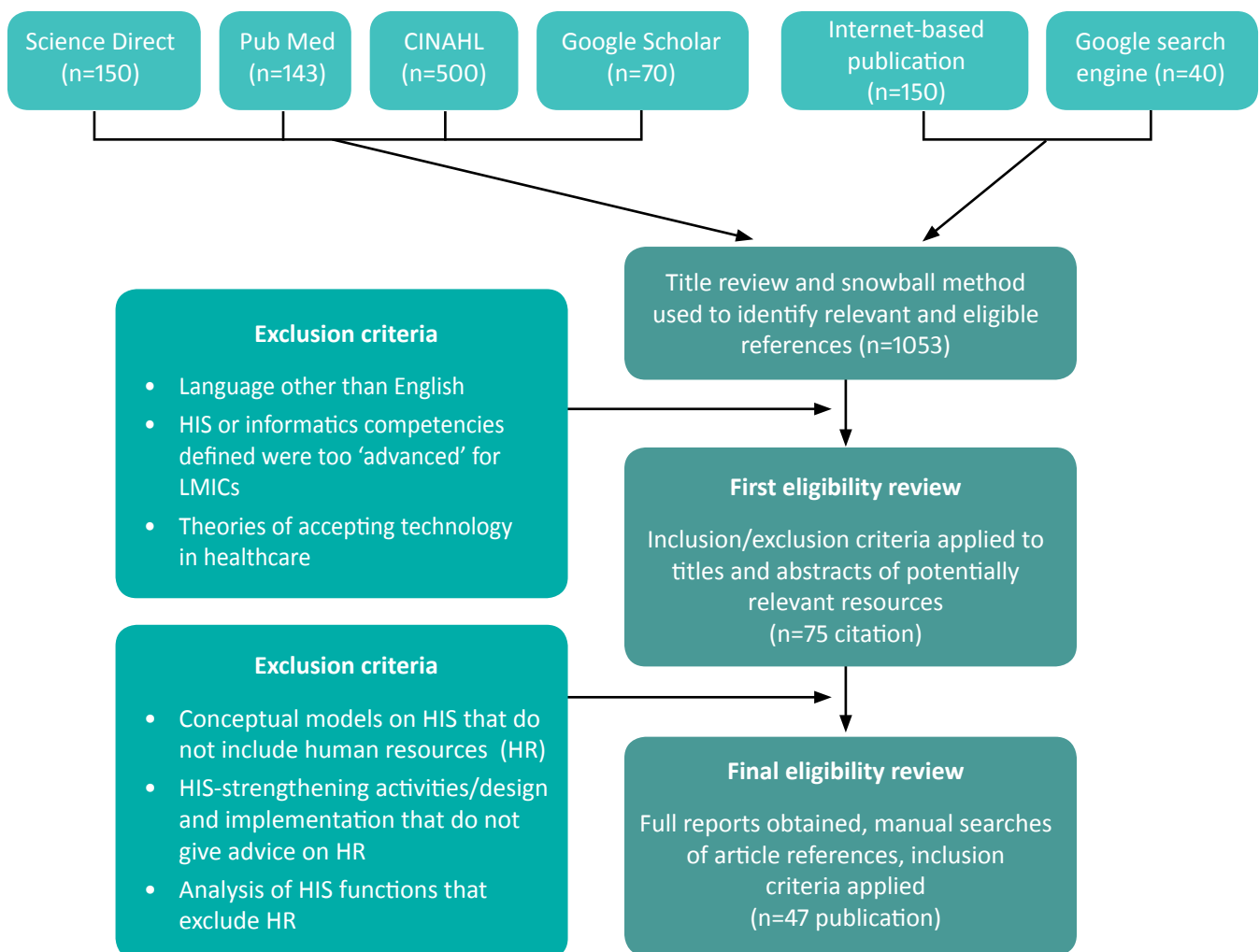
Figure 3 Overview of literature review process

From the 47 publications and resources included in the final literature review, we identified the definitions, roles and competencies that health workers require to undertake routine HIS activities in their level of the health system. We synthesised multiple competencies from the review and compiled them to produce the draft competencies framework for use in the expert feedback in the two rounds of consultation.

The literature review extracted several studies which had used the Delphi method to investigate competencies for health professionals. For example, the study by Staggers (2002) used the Delphi method to arrive at a research-based master list of informatics competencies for nurses at four levels of practice. We felt that this approach was pertinent to our study as it provided a structured process but one that would also allow qualitative information to be captured from experts in different countries. The way Staggers (2002) structured the conceptual framework around several levels of practice also informed the present study and the derived conceptual framework, as shown in Figure 2.
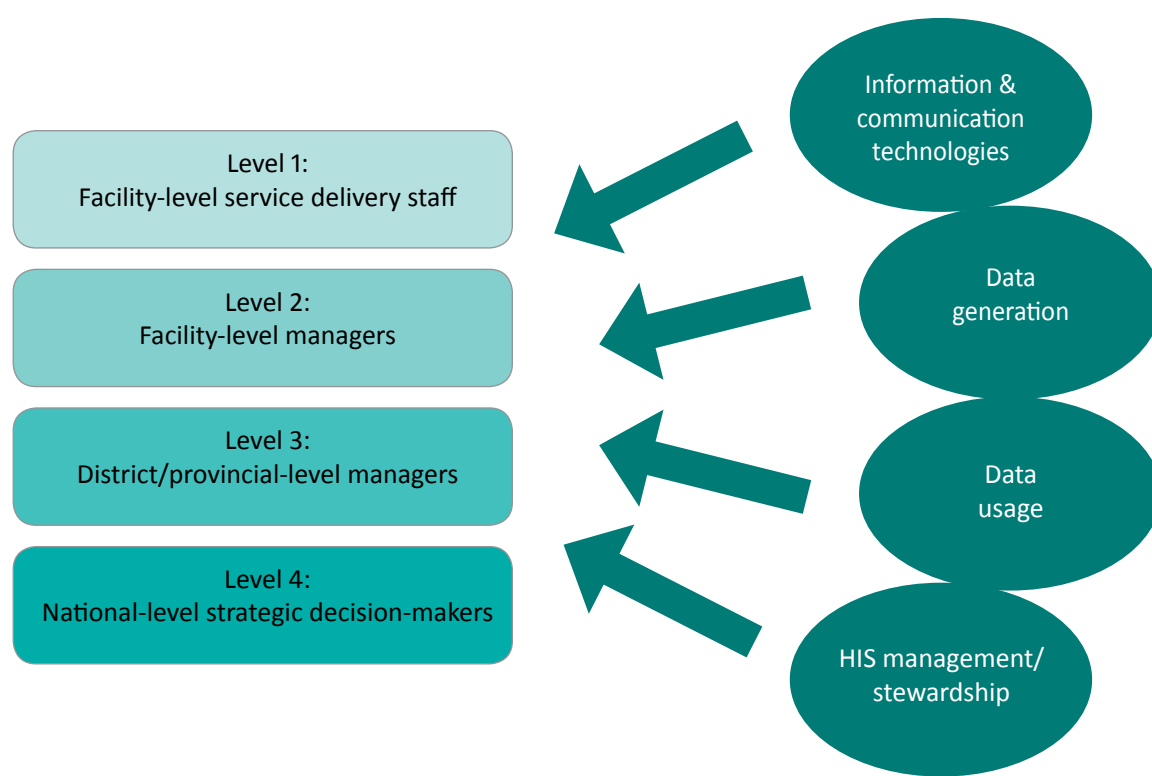
Figure 2 Conceptual framework for mapping competencies to levels of the health system

Expert consultation

After we developed a conceptual framework and a draft set of competencies, we wished to: (i) confirm the validity of the concept of a minimum framework of HIS competencies for health workers in LMICs, (ii) gain consensus on the competencies in the draft framework, and (iii) capture additional qualitative feedback relevant to the context of developing health information system-competent human resources for health in LMICs. We originally intended undertaking consultations at the Asia Pacific Leadership Forum on Health Information Systems which was scheduled for the second half of 2012. However, as the forum was delayed by 12 months, we opted instead to use a modification of the Delphi technique with a panel of selected experts.

We created a quantitative survey instrument with open-ended questions based on the Delphi method (Dalkey & Helmer 1963). It is a widely used and accepted method for gathering data from respondents within their domain of expertise. The Delphi method is a group communication process that uses a series of questionnaires delivered in multiple iterations to collect data from a panel of selected subjects and to arrive at a convergence of opinion. It usually involves at least three rounds of surveying, however, in the current study there were only two rounds of consultation with the expert panel. The presentation and feedback on this working paper will in effect constitute the third round of the survey.

We purposively sampled 38 participants with broad-based knowledge of health information systems and extensive experience working in development settings, especially at the operational level. These experts were identified from their attendance at the 2011 Asia Pacific Leadership Forum on Health Information Systems in Manila and from the Health Information Systems Knowledge Hub (HIS Hub) mailing list. Two of the experts were members of HIS Hub's Technical Advisory Group. The survey was distributed via email to the selected HIS experts who were located in different countries and had a range of areas of HIS expertise as shown in Table 2.

Health Information Systems Knowledge Hub

Table 2 Areas of health information system working experience of expert panellists

Health statistics and information
Applications Development Manager
Evaluation of health information systems
Public health information system
Monitoring and Evaluation Systems Advisor
Health information system strengthening and capacity development
Programme Management and Monitoring Unit

First-round consultation

The objective of the first round of consultation was to establish the validity of the 'concept' of the framework, that is, concurrence that there are general and specialised HIS competencies required at various levels of the health system and that these could be developed into a framework to inform human resource development. In response to the literature review, and prior to the round-one consultation, we defined four levels of practice for health staff in LMICs:

- Level 1: Service providers
- Level 2: Facility-based supervisors
- Level 3: Provincial-/district-level managers
- Level 4: National strategic decision-makers.

In the first round of consultation we presented the participants with the four levels of practice. We did not present the draft competencies at this stage. We asked respondents if they agreed or disagreed with the classification of the above levels of practice and whether they thought there were general and specialised HIS competencies for each level. An open discussion of the reasons for their responses, further comments and additional insights were captured.

We analysed the responses from the first round of surveys and used them to modify the draft competencies framework and the survey tool in preparation for the second round of comment.

Second-round consultation

The objective of the second round of consultation was to gain specific feedback on the draft competencies in the format of a framework. The framework listed over 70 competencies mapped against the four levels of practice. A number of general health information core system competencies were listed in the lower service levels and built upon with specialisation and progression up the levels of the system. We presented this framework to the expert panel using a similar question format to the first round with the aim of determining whether there was agreement with the content, the reasons for any divergence or disagreement, whether additional strategic information categories were required, and to allow further comment or clarification on these categories. Were analysed responses from the first- and second-round surveys using the Qualtrics software and performed content analysis on open-ended answers.

Results

Literature review

Study design

Several studies have used the Delphi method with expert panels to derive a list of functional descriptions of the services and activities of health staff (Hart 2010; Staggers 2002; Westra & Delaney 2007, 2008). Although several of them did not use the term 'competencies', their detailed descriptions of tasks, roles and outputs and how their method elaborated on these functions was of relevance to the present study. The paper by Staggers (2002) was explicit in defining competencies, but they were competencies in health informatics for nurses in high-income countries, and thus the paper was only included for its methodological content. Staggers (2002) categorised nurses into one of four classes of informatics users: beginners, experienced, specialist and innovators. The study then used the Delphi method and expert opinions to populate competencies against each of these categories. This methodology was used to inform the first iteration of our framework, specifically the concept of the four levels of service.

Shortage in health information system competencies in the health workforce

It is well established in the literature that LMICs are facing HRH shortages, and that this is having a negative impact on the performance of health systems, particularly in terms of health service delivery (Chen et al. 2004). The 2006 edition of the World Health Report, for example, focused entirely on this issue (WHO 2006). The literature review however, revealed that there are comparatively few papers discussing the shortage of health information system-skills among general health personnel and even fewer papers which actually describe these skills and their ideal distribution across the health workforce.

A study in Ethiopia and Zambia commissioned in 2009, was in fact one of the first to investigate the effects of a shortage of healthcare workers on the collection and use of health information (Cristofari et al. 2009). The authors found that in the absence of specialised HIS roles it was important that general health workers were able to perform basic HIS tasks, as exemplified by the quote, 'A general increase in the number of "medical staff" [sic] would address the medical staff shortage and the effects of this on health information

management, as information tasks could be shared'. The authors noted the need for health managers to emphasise the importance of data and its use among staff and to provide staff with more training and feedback around health information systems. Braa et al. (2007) similarly described that a shortage of staff with skills in HMIS led to increased workloads for nurses and other front-line health staff. Cristofari et al. (2009) described the expectations in rural Africa, that nurses and environmental health technicians perform HIS tasks, and even documented that in acute staff shortages that these tasks may fall on community volunteers or maids. A review of 10 primary healthcare clinics in South Africa found that only one clinic had a data-entry clerk. All clinics reported a high perceived work burden for data collection and collation and seven of the clinics reported that collation took a staff member approximately two days per month (Garrib et al. 2008). It thus seems evident that especially at the facility level, all staff should have basic skills in health information systems.

However, this finding was somewhat at odds with literature which highlighted the fact that many health staff do not necessarily see HIS tasks as their role. It was noted, particularly at peripheral levels, that staff view HIS tasks as an unwelcome additional burden that detracts from their primary role as service providers (WHO 2008). The literature showed that HIS tasks and competencies are often not well defined in the position/role description for general healthcare workers (Wilkins et al. 2008; Cristofari et al. 2009; Loveday et al. 2006) and accordingly, staff reported a lack of confidence in their ability to perform HIS tasks (Kawale 2011; Aqil et al. 2009). An investigation into the capacity of rural Malawian health workers to perform HIS tasks revealed a difference between their confidence levels and their observed competence in completing those tasks (Kawale 2011). The mean self-assessed confidence level for health facility managers in undertaking HIS tasks was 50.8 per cent, significantly higher than their objectively assessed mean competence level for HIS tasks at just 32.9 per cent. This information highlights the fact that competencies should be able to be objectively assessed and not subject to self-reporting.

In light of the documented lack of definition of HIS skills in general health-worker positions, it is not surprising that there was very limited literature which defined HIS competencies and/or capacity building activities for health staff in LMICs. Several studies of high-income countries described competencies for HIS specialist roles,

or competencies in health informatics for general health staff (Hersh et al. 2010; Holden et al. 2009; Staggers 2002; Westra & Delaney 2007; Wu et al. 2009). However, as the level of minimum competencies in this setting is quite advanced, we only put forward competencies for inclusion in the draft framework that were at an appropriate level. The level of health informatics is rapidly increasing in LMICs and this area warrants further study.

Health facility-level competencies

In terms of defining competencies at various levels, Braa and Hedberg (2002) suggested that staff at the health facility level, should be able to collect, collate and report data. These basic functions are supported by Finau (1994) and Cristofari et al. (2009), who also stipulate that there should be a focus on regularly collected quality data that is timely and verified against the raw data. Lippeveld et al. (2000) similarly underscore the importance of good quality data. Several authors (Braa et al. 2007; Cristofari et al. 2009) describe the correct use of standard health system forms as a core competency for health workers. Cristofari et al. (2009) did note, however, that nurses and front-line healthcare staff in Zambia and Ethiopia were not able to correctly complete standard forms because they had not received training. They also noted that this finding was discordant with the Zambian Ministry of Health's expectation that staff at the facility level should be able to collate, analyse and use data. The authors thus recommended that all primary healthcare courses should include training on completion of standard forms and tally sheets, and provide health workers with basic skills to perform preliminary data collection and analysis.

Facility-level supervisory competencies

The District Health Management Information System (DHMIS) Policy in South Africa states that facility managers are responsible for data accuracy and are tasked with: supervising assessments undertaken in the facility; validating data through cross-tabulation; and reporting the data to the next supervisory level (National Department of Health, Republic of South Africa 2011). The authors recommend that facility managers partake in monthly management meetings to discuss data collection problems and implement remedial interventions. Finau (1994) suggests that all sub-national staff need to be both information generators and data users, and that they should be able to store and retrieve data from

their health system regardless of whether the system is manual or electronic. Defined competencies for these staff include the ability to: 'crunch numbers', disseminate information, and to demand the information needed to inform their practice. Lippeveld et al. (2000) outline how supervisors need to have another level of skills and abilities above that of the front-line staff so that they can provide feedback, both to higher levels and to the facility-level staff. Further, they state that in addition to collecting and forwarding routine health information to the national level, that staff at the district and provincial levels need to be capable of managing budgets, coordinating services and planning. This information was used in the current study to assist in the definition of competencies which staff would require to perform these tasks.

District-/provincial-level competencies

Staff at the provincial level, and in decentralised contexts, were described as needing skills in data analysis, the capacity to use data to develop a situation analysis and the ability to develop responsive health plans based on this information (Lippeveld et al. 2000). Braa et al. (2007) also emphasise that district-/provincial-level staff should be able to use the health information system innovatively to collect local health indicators in response to their needs. Braa, Monteiro & Sahay (2004) state that staff at this level should have master-level training in epidemiology or statistics and advanced computer skills, or potentially a master in health informatics.

The South African DHMIS Policy recommends that district and provincial managers should have a similar responsibility and accountability for the quality of data produced in their facility as stipulated for facility-level managers. The policy states that district/provincial managers should regularly validate the data collected under their supervision; conduct regular management meetings in which they discuss problems in data collection and collation; and implement remedial action where data show inadequate performance against targets (National Department of Health, Republic of South Africa 2011). Loevinsohn (1994) was more explicit on the presentation skills required for data analysis and dissemination, stating that mid-level managers should be competent in the construction of cumulative graphs and pie charts, and be able to calculate simple rates and their change over time.

Regional-/national-level competencies

At the upper levels of the health system, Lippeveld et al. (2000) believe that staff should be able to use data for monitoring, management of staff, budgeting and auditing health expenditure, and for logistics management. They further stipulate that at the national level, data should be used for resource allocation, human resource planning and development, and purchasing and distribution. Data should be validated at each level of the health system, including the Department of Health and quarterly performance reviews should be conducted as mandated by policy. Yarbrough Landry, Stowe and Haefner (2012) state that in terms of health technology and information management, healthcare executives should understand both current and potential uses of clinical, administrative and decision-support systems and actively seek new information to inform their practice.

Informatics competencies

In their studies on informatics competencies for nursing and healthcare leaders, Westra and Delaney (2007, 2008) noted that required competencies are often ill-defined and have historically not been addressed through mandatory education. The authors used the Delphi method to define a list of competencies addressing the unique knowledge and skills required by managers and administrators. They compiled competencies across three major components: computer skills (i.e. the use of basic software applications, email and electronic patient records), informatics knowledge (i.e. knowledge of data issues and information system concepts) and informatics skills (such as selection of, implementation and management of information systems). The authors concluded that competencies are necessary for staff at all levels and should be explicitly documented in their roles and incorporated into training curricula.

Health information systems in LMICs are often paper based and have not moved to electronic records. For instance, in a HIS study in Malawi, only 25 per cent of the health centres surveyed had a computer and none of the centres had the internet (Kawale 2011). For this reason, the competencies formulated in this paper were only used as a reference. Therefore, it should be assumed that informatics technology and resulting competencies are likely to be low in LMIC settings and accordingly ICT competencies should be viewed as 'additional extras'.

Expert consultation

Round-one feedback

The feedback from the primary round of surveying was intended solely to derive consensus on the concept of the framework and the hierarchy of the four service levels in terms of responsibilities around data use, data generation, and management/stewardship of the health information system. In round one, 17 experts agreed to participate in the study and 11 of them (65%) completed the survey.

Respondents initially questioned whether the competencies should focus on staff that were specialised in health information systems, or should be targeted at general health workers across the health system. Acknowledging that many LMICs have very few specialised HIS roles, we clarified that the key focus in this survey was on mapping the HIS competencies for general health staff at various levels of the system. In light of this clarification, respondents agreed that there was a need for all health workers to have some basic HIS skills and that there was validity to the concept of a framework. One respondent expressed concern that putting competencies against the established levels would form a rigid hierarchy and suggested instead that it would be better to identify general tasks that all positions across the health system should perform. For example, all health workers collect data in some form and it is really the scope and scale of such activities that differs at various levels of the system.

We incorporated this feedback into the second-round survey to ensure that it captured generic HIS processes across the system, and that complexity and specialisation increased with progression up the hierarchy. We also accepted the four levels of practice as a way of showing the progression of skills and responsibilities expected at higher levels of the system. Several experts commented that these levels should be viewed somewhat arbitrarily as they are not always clearly delineated, and responsibilities at any level are dependent on factors such as the level of decentralisation in the health system and the levels of staffing at particular facilities. For example, in small facilities with only one service provider, that staff member may need to take on duties that span both levels one and two (i.e. service provision and reporting to the district level). Respondents provided feedback as to how the roles at each level should be elaborated, resulting in the following descriptions.

- Level 1: Service providers – Staff with basic data-generation skills and who use existing information systems and available information to manage their practice. They may be required to attend to the administrative duties in the absence of the facility-based supervisor.

- Level 2: Facility-based supervisors – Team leaders who coordinate both administrative and clinical staff; implement provincial-/district-level health-information-system activities; and assist in planning, directing and coordinating medical and health services.

- Level 3: Provincial-/district-level managers – Staff with additional knowledge and skills specific to leadership and management who focus on the production and dissemination of provincial-/district-level information; implement national and provincial level activities; and assist in planning, directing and coordinating medical and health services on a provincial and district level.

- Level 4: National strategic decision-makers – Staff with additional knowledge and skills specific to leadership and management at the national level who develop up-to-date legislation providing a framework for health information data sources and collection; implement national-level health-information-system activities; and assist in planning, directing and coordinating medical and health services nationally.

An important point that came out of the discussions was that some respondents were unsure what we actually meant by 'competencies'. Many of them were describing the roles and responsibilities of various positions, but not the actual skill set required. In response, we incorporated this feedback into the second round of the survey. We made it clear that we are defining health-information-system skills, not specific positions, and that it is these skills which all health workers need to possess to ensure that they can undertake health information system-oriented tasks as an embedded function of their operational roles.

Finally, in agreement with the findings of the literature review, there was consensus that competencies around ICT were not relevant for all LMIC settings and therefore should not be included as core competencies. In order to accommodate countries that have some form of ICT, we decided that ICT competencies should be included as a separate module; a concept which we applied to the second round of surveying.

Round-two feedback

In the second-round consultation, we presented respondents with a draft competency framework using the forgoing four practice levels and lists of HIS competencies which had been derived from the literature. The listed competencies were more basic in the lower levels, with each progressive level expected to build upon the competencies of the lower levels. We provided an additional list of competencies for generic ICT skills for comment. We asked respondents to move competencies between levels, and to add or delete competencies as they saw fit. In this round of consultation, 11 experts agreed to participate in the study and 8 of them (73%) completed the survey.

Consensus was reached around the inclusion of 68 competencies stretching across the four levels of the health system as shown in Table 3. The competencies in Level 1 are viewed as core competencies which are built upon and each level adds competencies on top of the previous level (i.e. Level 2 staff would be expected to have all the competencies listed in levels 1 and 2, staff at Level 3 all of the competencies listed in levels 1 to 3, and Level 4 staff all of the competencies). Regarding competencies around ICT, the selected competencies were thought to be relevant across all levels that had necessary communication infrastructure (i.e. computers, internet and software).

Table 3 Framework of health information system (HIS) competencies for health workers at four levels

Level 1: Facility-based (service providers)	Level 2: Facility-based (supervisors)	Level 3: Provincial-/district-level (managers)	L4: National (strategic decision-makers)
Management (including use of administrative processes and systems), oversight and coordination			
1. Uses administrative processes for longitudinal patient monitoring and practice management (e.g. searches for patient records, retrieves demographics)	1. Uses administrative processes for maintaining employee records	1. Manages projects and provincial-/district- level administration	1. Plans and coordinates the national-level surveillance and response activities across all levels of the health system during public health emergencies
	2. Uses administrative processes for budgeting	2. Develops HIS capacity- building activities across the health system	2. Develops up-to-date legislation and health in-formation policies and pro-cedures which provide the framework for implementing the national HIS standards
	3. Uses administrative processes for staff scheduling	3. Understands provincial/district minimum core health indicators which have been identified for the country (health status and determinants; inputs, outputs and outcomes of the health system)	3. Oversees and monitors the operations/functions of the HIS at the Ministry of Health
	4. Uses administrative processes for forecasting facility-level resource allocation	4. Establishes coordination mechanisms for the provincial/district statistics office	
	5. Organises staff workshops and training sessions related to HIS strengthening		
	6. Uses a systematic approach to evaluating the quality of services provided by health facilities according to national HIS standards		

Data generation (collection, analysis, management & dissemination)			
Level 1: Facility-based (service providers)	**L2: Facility-based (supervisors)**	**L3: Provincial-/district-level (managers)**	**L4: National (strategic decision-makers)**
1. Documents patient care using appropriate forms (in accordance with national and/or facility standards)	1. Reports regularly on facility supplies, infrastructure, human resources, commodities, budget and equipment	1. Reports regularly on a minimum set of core indicators	1. Disseminates health reports and national HIS standards to lower level health facilities and offices
2. Enters patient data and facility-level health indicators using appropriate forms (in accordance with the national HIS standards)	2. Uses facility and national HIS standrads for proper filing and storage of confidential data	2. Develops reports for the Provicial/District Health Account	
3. Accesses, and retrieves data at facility level for patient care and health service administration (e.g. filing system)	3. compiles and manages aggregate data	3. Follows natiobnal HIS standards for data management, analysis, and use at provincial/district level	
4. Completes and submits all forms (i.e. weekly/monthly summary and surveillance reports) to the district level health office in a timely manner using the correct practice for paper-based documentation (according to national and/or facility standards)	4. Accesses shared data sets	4. Ensures accuracy of data collection at health facility	
5. Undertakes proper coding/classification, filing and storage of confidential data as per national HIS data entry and facility standards and as appropriate at the facility level (e.g. diagnosis)	5. Uses and understands diagnostic coding	5. Publishes most recent summary reports for local authorities	
6. Performs transcription, analysis and compilation of data as required by district and/or national health office		6. Disseminates health information used by Provincial/District and Facility level management teams to set resource allocation in the annual budget	

Data generation (collection, analysis, management & dissemination)			
Level 1: Facility-based (service providers)	**L2: Facility-based (supervisors)**	**L3: Provincial-/district-level (managers)**	**L4: National (strategic decision-makers)**
7. Maintains privacy and security of confidential data		7. Provides information and analysis to health facilities and other administrative units as per national HIS standards	
8. Creates documentation that is thorough and legible		8. Develops integrated HIS summary reports including minimum set of core indicators as per national HIS standards	
		9. Accesses processes and analyses facility level data as per national HIS	
		10. Extracts data from clinical and public health data sets	
Data use			
Level 1: Facility-based (service providers)	**L2: Facility-based (supervisors)**	**L3: Provincial-/district-level (managers)**	**L4: National (strategic decision-makers)**
1. Uses or provides surveillance data to respond to outbreaks according to national standards	1. Uses patient records and/or facility health reports to monitor health outcomes	1. Uses health information in developing the annual budget plan	1. Uses health information in national strategic planning and budget development
2. Uses or provides information on forms (national and/or facility standards) to plan patient care (e.g. discharge planning)	2. Uses facility level reports for decision making on facility-level resource allocation (e.g. supplies, human resources, finances)	2. Uses health information at all levels for managing delivery of the local health service, and for continuous monitoring and periodic surveillance and response	2. Uses integrated HIS summary reports including a minimum set of core indicators to set up strategic management agendas
3. Uses or provides facility-retained patient medical records to support quality and continuity of care	3. Uses data to evaluate service delivery and health outcomes, and to improve quality of care at the facility level		3. Uses lower level reports and national HIS reports for future HIS directional planning
4. Uses or provides data relating to practice and care as per national HIS standards			4. Uses health information in annual national planning and budget development

Use of ICT infrastructure (subject to availability and applicability at each level)
1. Uses available communication infrastructure (e.g. fax, telephone, computer, copier, internet, email)
2. Demonstrates basic technology skills (e.g. able to operate computer, print documents, load paper, change toner)
3. Demonstrates keyboard skills (i.e. typing)
4. Uses operating system applicable to role (e.g. copy, paste, delete, manage files, change directories, adjust monitor and settings)
5. Uses computer technology safely and securely
6. Operates peripheral devices (e.g. handheld, scanner, portable storage devices)
7. Uses surge protection if provided
8. Uses word processing (e.g, Microsoft Word)
9. Uses spreadsheets (e.g. Microsoft Excel)
10. Routinely saves and backs up files
11. Operates virus-scanning processes
12. Uses presentation graphics (e.g. Excel graphs/PowerPoint)
13. Uses applications for structured data entry (e.g. patient data, service data)
14. Uses administrative applications to collate data and develop reports at facility level for decision-making (e.g. customised databases or HIS software applications)
15. Uses networks to navigate systems (e.g. local area networks, world wide web)
16. Undertakes simple preventive maintenance of computer (e.g. operating system and software updates)
17. Uses aids for clinical decision-making or service decision-support systems

Excluding the 17 ICT competencies which are considered relevant at all levels, the breakdown of the remaining 51 competencies per level and competency area is shown in Table 4. This analysis reveals that almost half (n=24) of the competencies across the four levels are associated with data generation, particularly at levels 1 and 3. This indicates that staff at these levels, and indeed all staff, may benefit greatly from training which focuses on data collection, collation and analysis, including training on how to use standardised forms and reporting procedures. The number of competencies relating to data usage was quite similar across all levels. This indicates that all staff are expected to not only generate data but to also use data to inform their practice. Not surprisingly, the management and stewardship competencies were demanded more of staff at the

higher three levels of the system. Table 4 also shows that there are approximately 14 new competencies expected at each of the levels 1, 2 and 3; and roughly half this new number expected at Level 4 (the national/regional level). We can therefore infer that specific training is required for staff to be able to adequately perform HIS tasks at each level of the system.

HIS tasks should be included as a key competency. The respondent argues that the flow of information should be bi-directional with reporting being complemented by performance feedback. We received this feedback after the Delphi rounds for arriving at a consensus had been completed and, therefore, these competencies have not been included in the framework, although they warrant

Table 4 Competencies per level of service

Competency type	Number of competencies			
	Level 1	Level 2	Level 3	Level 4
Data generation	8	5	10	1
Data usage	4	3	2	4
Management and stewardship	1	6	4	3
Total	13	14	16	8
Cumulative total	13	27	43	51

In addition to the competencies set out above, there were many that did not reach consensus. This is not surprising considering the diverse professional backgrounds and interest areas of the respondents. For example, while the majority of respondents thought competencies were too advanced, several respondents felt that at the provincial and national levels, competencies should include the ability to use data presented in geo-referenced formats, and ICT competencies such as an understanding of enterprise architecture and the interoperability of systems. A late response from one respondent felt that a key Level 4 data-management competency, 'defines HIS information and work flows and maintains a set of health data standards (syntactic and semantic) to foster systems interoperability' should be included, as should the Level 4 data-generation competency, 'develops clear health data and indicator definitions with metadata'. This respondent also pointed out a key omission—in the top three levels of the system, providing feedback on

serious consideration for future drafts of the framework.

Some respondents felt that competencies around generic management skills, such as change management, risk management, and good communication and networking skills, should be included in the higher level skill sets. However, as we intended to keep the list of competencies focused on those that are specific to health information systems, these sorts of generic skills were not included. Others items that did not reach a consensus for inclusion included competencies around economic analyses such as cost-benefit analyses, or competencies focused in detail on surveillance and monitoring and evaluation. A few respondents wished to have competencies based around specific types of data, for example demographic or statistical data. We did note this type of qualitative feedback, but our ability to delve into specific content areas was outside the scope of the present study and warrants future research.

Discussion

The study revealed that in addition to a shortage of staff who are specialised in health information systems, general health staff in LIMCs also commonly lack the confidence and competence to perform HIS tasks. A contributing factor is poor general awareness of the importance of health information systems as described by one respondent, 'at present, most of the facility-based supervisors are unaware about the health information system and its utility'. All too often it seems that staff have limited cognisance of the value and potential public health uses of data; they collect data simply because they are told to. If staff, particularly at the lower levels, do not recognise the benefits of collecting and using the data, their motivation to collect complete and accurate data is likely to be low. An added issue is that HIS roles and responsibilities lack clarity. For example, several respondents note that the health information system is often seen only as the domain of data-entry clerks and HIS specialists such as epidemiologists and information managers. It was evident from the literature that this view of health information systems as a specialist role has created a widespread attitude among health staff that HIS tasks are 'additional burdens' which are not strictly part of their role. This view is confounded by the lack of HIS competencies in training, professional development and role descriptions. To counteract this finding, health systems need to promote and incentivise a 'culture of information' by ensuring that all personnel within the health system are aware of their duties in supporting the health information system. This includes both duties of generating and using data and through stewardship of the system. Staff also need to recognise that these duties are a core component of *all* roles in the health system.

Although respondents thought the concept of the framework was useful, they stated that staff in LIMCs often work across several roles and levels and thus the framework would need to be somewhat flexible.

Furthermore, many respondents said that although they felt the framework was theoretically sound, in reality, staff in many levels of the health systems in LMICs would not have even the basic competencies listed in the first level of the framework and it should thus be applied with careful consideration. It seems that if the framework is to be used to inform training or curriculum development, it may be beneficial to prioritise the competencies or further refine a shortlist of five or six essential competencies for initial focus. Defining competencies is of course only one step in developing a health workforce that is skilled to support health information systems. Ideally, the Ministry of Health in each country should take responsibility for creating and enforcing a minimum level of HIS task competence in alignment with the promotion of a culture of information and a supportive environment which provides adequate training and supervision.

The current study generated a lot of discussion, revealing that there is limited understanding and consensus around what constitutes a health information system, the definition of competencies, and how HIS competencies apply to general health roles. The proficiency levels required at different levels of national health systems need to be further defined and the competency requirements within various services of the health system need elaboration. Given that several respondents stated that they did not have time to complete the survey (suggesting a shortage of HIS experts who are also time poor), we plan further iterations of the framework at the next Asia Pacific Leadership Forum where such stakeholders will gather. There have in fact been a number of requests to receive the framework from the 38 experts initially contacted to participate (including several who did not participate), demonstrating that there is a high level of interest in this research and the final product.

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Conclusions

Health information is of vital importance for decision-making, resource allocation, quality and continuity of care, and evaluation of the health system. In accordance with the discussions at the Asia Pacific *Leadership Forum* on Health Information Systems in 2011, the present study found limited evidence of general HIS training modules in LMICs, and a need to develop a competency-based framework to inform this training. We hope that this study and the competency framework it derived will serve to create further dialogue and action in this neglected but important area in line with the following recommendations.

- Governments should increase national budgets for health information systems. This is warranted given that the greatest HIS return on investments is in people, rather than technological solutions.

- Health system managers should create and incentivise a 'culture of information' which places inherent value on data production, analysis and use.

- Health system managers should also take responsibility for training its workforce to understand the importance and benefits of collecting data, thereby increasing staff motivation to collect and use data.

- Health staff duties/tasks should be clarified and their required skills better defined to improve staff understanding of their role in the health information system.

- Managers and planners should seek to establish the current competency levels of staff and use this information to plan and implement ongoing training programs and professional development activities to ensure that there are adequate numbers of suitably trained staff.

- HIS competencies, including both core health information and ICT competencies, should be used to define role descriptions and guide curriculum development for health workers.

- National health departments should further define the minimum levels of proficiency at different tiers of the national health system and across different services in the system.

In addition to action on the recommendations above, the health system needs to have adequate numbers of personnel who are:

i.   aware of their role in the health information system

ii. trained to undertake HIS tasks

iii. incentivised and motivated to collect and use data to improve their practice.

Such outcomes will ensure that high quality data is generated by the health system and available to inform planning and decision-making. The health information system is a key health system building block and thus investment in the human resources required to run it is essential for health system development and strengthening, particularly in LIMCs.

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The Knowledge Hubs for Health Initiative

The Health Information Systems Knowledge Hub is one of four hubs established by AusAID in 2008 as part of the Australian Government's commitment to meeting the Millennium Development Goals and improving health in the Asia and Pacific regions. All four hubs share the common goal of expanding the expertise and knowledge base to help inform and guide health policy.

The Knowledge Hubs are funded by AusAID's Strategic Partnership for Health Initiative.

Health Information Systems Knowledge Hub

The University of Queensland

Aims to facilitate the development and integration of health information systems into the broader health system strengthening agenda, and increase local capacity to ensure that cost-effective, timely, reliable and relevant information is available. The Health Information Systems Knowledge Hub also aims to better inform health information systems policies across Asia and the Pacific.
www.uq.edu.au/hishub

Human Resources for Health Knowledge Hub

The University of New South Wales

Aims to contribute to the quality and effectiveness of Australia's engagement in the health sector in the Asia–Pacific region by developing innovative policy options for strengthening human resources for health systems. The hub supports regional, national and international partners to develop effective evidence-informed national policy-making in the field of human resources for health.
www.hrhhub.unsw.edu.au

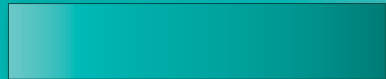### Health Policy and Health Finance Knowledge Hub

The Nossal Institute for Global Health (University of Melbourne)

Aims to support regional, national and international partners to develop effective evidence-informed national policy-making, particularly in the field of health finance and health systems. Key thematic areas for this hub include comparative analysis of health finance interventions and health system outcomes; the role of non-state providers of health care; and health policy development in the Pacific.
www.ni.unimelb.edu.au

Compass: Women's and Children's Health Knowledge Hub

Compass is a partnership between the Centre for International Child Health, The University of Melbourne, Menzies School of Health Research and Burnet Institute's Centre for International Health.

Aims to enhance the quality and effectiveness of women's and children's health interventions and focuses on supporting the Millennium Development Goals 4 and 5—improved maternal and child health, and universal access to reproductive health. Key thematic areas for this hub include regional strategies for child survival; strengthening health systems for maternal and newborn health; adolescent reproductive health; and nutrition.
www.wchknowledgehub.com.au

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