Evaluation of the District Health Information System 2 Supported Malaria Reporting System in Solomon Islands

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Abstract

Background

District Health Information Systems 2 (DHIS2) is used for supporting health information management in 67 countries, including Solomon Islands. However, there have been few published evaluations of the performance of DHIS2-enhanced disease reporting systems, in particular for managing infectious diseases such as malaria. The aim of this study was to evaluate DHIS2 supported malaria reporting in Solomon Islands and to develop recommendations for improving the system.

Methods

The evaluation was conducted in three administrative areas of Solomon Islands: Honoria City Council, and Malaita and Gundacanal Provinces. Records of nine malaria indicators from 1st January to 31st December 2016 were extracted from the DHIS2 database. The indicators permitted assessment in four core areas: availability, completeness, timeliness and reliability. To obtain more detailed information on performance of the malaria case reporting system, focus group discussions (FGD) were conducted with health centre nurses, whilst in-depth interviews (IDI) were conducted with stakeholder representatives from government (province and national) staff and WHO officials who were users of DHIS2.

Results

Data were extracted from nine health centres in Honoria City Council and 64 health centres in Malaita Province. Overall, completeness of all nine indicators was 28.2% and 5.1% of health centres submitted reports on time. The most reliable indicator in DHIS2 was ‘clinical malaria’ (i.e. numbers of clinically diagnosed malaria cases) with 62.4% reliability. Challenges to completeness were a lack of supervision, limited feedback, high workload, and a lack of training and refresher courses. Health centres located in geographically remote areas, a lack of regular transport, high workload and too many variables in the reporting forms led to delays in timely reporting. Reliability of reports was impacted by a lack of technical professionals such as statisticians and unavailability of tally sheets and reporting forms.

Conclusion

The availability, completeness, timeliness and reliability of nine malaria indicators collected in DHIS2 were variable within the study area, but generally low. Continued onsite support, supervision, feedback and additional enhancements such as electronic reporting will be required to further improve the malaria reporting system.

Introduction

In 2018, an estimated 228 million cases of malaria occurred worldwide, with 405,000 deaths [1]. Malaria disproportionately affects children under 5 years, who accounted for up to 67% of all malaria deaths in

2018. Incidence of malaria cases and deaths in Solomon Islands is amongst the highest of all countries in the World Health Organization (WHO) Western Pacific region [2].

Malaria remains a significant cause of morbidity in Solomon Islands. Almost the entire population of Solomon Islands is at high risk for malaria, with only 1% of the population living in areas free of malaria. Between 1993 and 1999, control measures were decentralized to the provinces and were mainly based on the use of insecticide-treated bed nets (ITNs), house spraying using dichlorodiphenyltrichloroethane (DDT) and community awareness programs [3]. In 2003, long-lasting insecticidal nets (LLINs) were introduced in Solomon Islands [4]. In 2008, Solomon Islands planned to eliminate malaria in one province by 2014 [4]. To support this national goal, case-based surveillance supported by a spatial decision support system (SDSS) was developed [5]. The SDSS was used for rapid case reporting and mapping, planning and deployment of preventive measures including indoor residual spraying (IRS) and LLINs [6, 7]. However, use of the SDSS declined and cases have rebounded since then; notably, cases increased from 30,591 in 2015 to 86,343 in 2018 [1].

Transforming malaria surveillance to become a core intervention strategy has been outlined in the *Global Technical Strategy for Malaria 2016–2030* (GTS) [8], and a key component is the improved use of data for decision-making. For health information management in resource-limited settings, WHO advocates the use of District Health Information Systems 2 (DHIS2). Since 1994, DHIS2 has evolved and is currently used in 67 countries for managing health information [9–12]. DHIS2 is an open-source information system with few hardware requirements, and a flexible user interface that allows users to specify their content without the need for programming [13–15] (Fig. 1). DHIS2 is a generic tool that needs to be customized for local use for specific purposes such as disease surveillance.

DHIS2 provides a vehicle for standardization of data collection processes across public health facilities of a particular jurisdiction, usually a country. The data contained in DHIS2 can provide a useful means of establishing disease burden baselines that can be compared across districts and over time, allowing for assessment of community needs, intervention impacts and to evaluate the performance of public health programmes [16, 17]. A number of studies have outlined factors that limit the utilization and effectiveness of DHIS2. First, the integration of DHIS2 in national surveillance systems has been limited by a transient health workforce including public health staff and data managers [15]. Second, the limited availability of human resource capacity for data analytics has constrained the use of data that are collected [13, 18]. Thirdly, data that are collected but not used are an untapped resource, and processes are needed to realize the potential value of the data collated within DHIS2 to inform action. Fourthly, crucial infrastructure is often lacking, including internet reliability and coverage [11, 13, 19, 20]. However, there has been no specific evaluation of DHIS2 as a tool to support infectious disease surveillance. The aim of this study was to evaluate the performance of the DHIS2-enhanced malaria case reporting system in Solomon Islands using a mixed-methods approach and to provide evidence for improvements in the system to support effective decision making.

Methods

Study site

Solomon Islands is a country located in the Melanesia sub-region of Oceania, with an estimated population of 667,044 in 2018 [21]. The country is administratively divided into nine provinces and Honoria City Council. Guadalcanal and Malaita provinces, and Honoria City Council, were selected for the current study because they report some of the highest numbers of malaria cases in the country, and they were relatively accessible to the study team (Fig. 2).

DHIS2 was introduced in Solomon Islands in 2015. As in other countries using DHIS2 around the world [22], malaria data are collated and compiled into a malaria case management reporting (MCMR) form every month at each health centre. The data come from various sources including outpatient records, microscopy, rapid diagnostic test (RDT) and stock registers and ledgers. These MCMR forms are sent to the provincial health office where they are entered into the web-based DHIS2. The software provides options to generate quarterly or yearly reports by health centre or a range of administrative levels. The data stored in DHIS2 are available to registered users and other stakeholders through a password-protected log-in system.

Data collection

Four core sets of criteria were used for the evaluation: availability, completeness, timeliness and reliability. Availability was defined as the presence or absence of malaria reporting forms at the provincial office. Completeness was defined as the percentage of observations within each of the nine indicators that were reported correctly. Timeliness was defined as submitting reports to provincial offices prior to the 15th day of the subsequent month. Reliability was defined as the percentage of monthly reports that matched the records between MCMR forms and DHIS2 (Table 1).

Table 1
Core areas and analysis plan for DHIS2 evaluation plan

Core areas	Indicators	Source	Reference source	Analysis
Availability	Presence/absence of monthly malaria report	Monthly malaria clinic reports	Not applicable	Presence/absence of monthly reports at province health departments
Completeness	Nine malaria indicators	MCMR	Not applicable	Proportion of completeness (total number of months with complete reporting in the selected health center/12 X number of health centres)
Timeliness	Nine malaria indicators	MCMR	Malaria clinics to provincial HIS	Time lag from the 15th of the subsequent month from malaria clinics to provincial HIS
Reliability	Nine malaria indicators	DHIS2	Province health registers	Percent matching months between MCMR and DHIS2

Data were extracted from nine centres in Honoria City Council and 64 health centres in Malaita Province. The MCMR records were not available for Gundacanal Province and so the quantitative component of the study did not include Guadalcanal. We compared recorded monthly figures of nine indicators recorded on paper MCMR forms with the data stored in DHIS2. Data pertaining to these indicators for the period 1st January to 31st December 2016 were extracted using a data extraction form. Results for each indicator were summarized by study province using means and percentages. Nine indicators in these four sets of criteria were extracted from the MCMR forms maintained at the respective provincial headquarters, and DHIS2. The details of the indicators are outlined in Table 2.

Table 2
Nine malaria indicatiors extracted from malaria case and morbidity reporting form

No.	Malaria indicators	Defination
1.	Report submission date	Date on which report was sent from health centre to provincial headquarters.
2.	Total malaria cases	Total number of both *Plasmodium falciparum and P. vivax* cases treated in the health centre in a month.
3.	*Plasmodium falciparum* case record	Total number of *P. falciparum* cases diagnosed and treated in the health centre in a month.
4.	*Plasmodium vivax* case record	Total number of *P. vivax* cases diagnosed and treated in the health centre in a month.
5.	Clinical malaria	Fever cases treated as malaria without blood test.
6.	Malaria diagnosed with microscopy	Total malaria cases (both *P. falciparum* and *P. vivax*) diagnosed with microscopy in a month.
7.	Malaria diagnosed with RDT	Total malaria cases (*P. falciparum)* diagnosed with microscopy in a month.
8.	Record of drug stocks	Drug balance in the health centre at the end of month.
9.	Records of RDT	RDT balance in the health centre at the end of month.

Three focus group discussions (FGD) with the nurses (25) of Malaita and Guadalcanal provinces, and Honoria City Council, were conducted in June 2017. Thirteen in-depth interviews (IDI) were run with key informants, also in June 2017. The FGD participants were purposively selected from the nurses of health centres who were involved in MCMR reporting, whilst the IDI participants were stakeholder representatives from government (province and national) and staff of the WHO country office who were working with DHIS2. FDG and IDI were undertaken to elicit opinions and feedback regarding the functionality and effectiveness of DHIS2 supported malaria reporting. During the interview, a flexible semistructure interview format was followed for both FGD and IDI. FGD lasted from 45 minutes to 1 hour and IDI were conducted face to face and lasted from 30–45 minutes.

Unlike most investigators undertaking conventional qualitative data collection and analysis, we did not have the opportunity to start data analysis from the very beginning of data collection, which can allow review of initial findings, identification of information gaps and tracking of data saturation [23]. Instead, we recorded all interviews in the first sitting and transcribed the interviews using professional transcriptors at a later date. A deductive coding method was used to identify major relevant themes relating to DHIS2 functionality and effectiveness. Pre-set coding schemes were formulated considering the study objectives, and were applied to the text. The authors read and reread the transcripts and highlighted text under each of the main themes. Data were extracted and displayed using a matrix table, then interpreted under each of the main themes. Finally, the qualitative and quantitative analyses were correlated to derive the study findings.

Results

Availability

Data were extracted from nine centres in Honoria City Council and 64 health centres in Malaita Province. The MCMR records were not available for Gundacanal Province. Microscopists usually undertook blood examination in health centres while RDTs were performed by nurses. Some of the facilities had shortage of RDTs and adequate number of OPD registers [“*(MCMR) book is there but sometimes need to photocopy extra copies for every table in OPD*” FDG3]. The results were recorded, and then compiled and collated using MCMR forms by the nurses at the health centres and submitted to the provincial headquarter every month [“*A lot of time, we come back at the end of the month [we try to come back] and fill up the forms and compile it. Those that were recorded in the OPD book it is easy for us to transfer to MCMR forms*” FGD2]. After MCMR forms reach the provincial headquarters, malaria monitoring and supervisor officers enter the data into the online DHIS2 software [“*So, my daily responsibility is for entering that (data) into the system (DHIS2)*” IDI9].

Completeness

Only 28% of reports were 100% complete for all nine indicators. The respondents had a good understanding of the completeness of reporting, including the need for regular reporting even when there were no cases to report [“ ‘*Forms completed’ means that each [form is] properly filled [with] no data missing*,” FGD1] and [“ ‘*completeness’ is filling all the things that are asked in the forms*” FGD2].

Nearly half (47.2%) of all indicators were complete in Honoria City Council, while only 25.5% were complete in Malaita Province. The highest completeness amongst the nine indicators was ‘*P. falciparum* diagnosed with RDT’ at 90.3%, followed by ‘*P. falciparum* and *P. vivax* diagnosed with a microscope’ at 90.1% each. The ‘stock balance of drugs’ and ‘stock balance of RDTs’ were the least complete indicators with 45.1% and 38.5% completeness respectively. Honoria City Council had better completeness than Malaita Province for all nine indicators. In Honoria City Council, ‘total parasites’, and ‘*P. falciparum* and *P. vivax* diagnosed with RDT’ were 95.4% complete. ‘RDT stock balance’ was the least complete indicator with only 53.8% complete. However, in Malaita Province, ‘*P. falciparum* diagnosed with microscopy’ was the most complete indicator, with 89.7% completeness, followed by ‘*P. falciparum* diagnosed with RDT’ with 89.6% completeness. Similar to Honoria City Council, ‘RDT stock balance’ was the least complete indicator with 36.5% completeness (Table 3).

Table 3
Completeness of nine indicators from malaria case and morbidity reporting forms, Solomon Islands

Indicators		Overall		HCC		MP	
		Number	%	Number	%	Number	%
Repoot submission date		559	63.8	86	79.6	473	61.6
Total parasites		770	87.9	103	95.4	667	86.9
PF	RDT	791	90.3	103	95.4	688	89.6
PF	MIC	789	90.1	100	92.6	689	89.7
PV	MIC	789	90.1	103	95.4	686	89.3
Clinical malaria		782	89.3	103	95.4	679	88.4
Total test	MIC	499	57.0	91	84.3	408	53.1
Total test	RDT	611	69.8	89	82.4	522	68.0
Drug stock		395	45.1	71	65.7	324	41.2
RDT stock		337	38.5	57	52.8	280	36.5

Several factors facilitated the completeness of reporting. Nurses were assisted in filling in all fields of the reporting forms by other staff members in the health centre such as microscopists and laboratory technicians. As they shared the same office premises, nurses sought the help of microscopist and laboratory technicians when they needed clarification on the data recorded by them. Other enablers included training and supervision of nurses by the provincial supervisors, [“*There should be … constant refresher [and] training in how the data should be documented because … those are the things [that] can improve [completeness]*” IDI10].

The study respondents also identified some challenges for the completeness of reporting. The handwriting of nurses was often not clear enough to understand the information written in the registers. Heavy workload critically affected the completeness of reporting, [“*There is a heavy workload, lots of times, …. there is lots of pressure, demand from patients and we run all over the place and in the end we forgot to write some [information] of these people in the record book*” FGD1]. As a result of a heavy workload, nurses often multi-tasked, including providing regular care to the clinic patients whilst attending to administrative matters such as recording in the registers [“.. *talking from my experience when a clinic does not have too many patients, we pay attention when filling up the forms. But when we have lots of patients and you are alone, that’s the problem*” FGD2]. A lack of regular training and refresher courses also led to incomplete forms, [“*In our unit, some of the staff [nurses] did not attend the training. So they lack the understanding of the filling up of forms [correctly]*” FDG1], and *[“[Provinical] officials should come and give us training. See that we are doing the right thing, [we] understand [filling] the form*

properly, then we will be able to [properly fill the forms]" FDG2]. The workload associated with reporting the individual records of all patients was seen as one of the reasons for incomplete reporting. This was true especially in some health centres with a large number of cases. In this regards, a participant in an IDI said, "*…for a small country like Solomon [Islands]… entering 86,000 cases … is a huge task. … for the some of the provinces you'll need at least two or three people just doing only this"* [IDI6].

Use of technology such as computers that can automatically summarize the records for the month at the centre level (as opposed to the health centre level, where DHIS2 is used to complete this task) can help improve the completeness of reporting, ["*I feel I should have a computer or program that I fill in the data here and it summarises the data at the end of the month …[so that] I don't have to do [a] tally*" FDG2]. The nurses thought that supervisory visits also helped in improving the completeness of reporting. During those visits, a supervisor would have the opportunity to review the draft report and provide feedback to the nurses if they find any incomplete or inconsistency reporting. However, regular supervisory visits were not often observed in all areas due to inadequate funding and availability of supervisory level staff members ["*[without supervisory visits] that's when nurses don't think seriously about the importance of these quality data collection because, like those at a higher level, they didn't come down and visit us to give feedback, supervision. We take this information for granted*" FGD2].

Timeliness

The interview respondents knew that the reports should reach the provincial headquarters by the 15th of the following month ["*From the province, they set up a timely reporting period for us if we submit before first two weeks or 15th of each month, then we are timely reporting*" FGD2]. However, there was a significant delay in submitting reports, with only 5.1% (45/976) of health centre-months submitting reports before the 15th of the subsequent month. The submission date was not recorded on 36.2% (317/876) of MCMR forms, making it difficult to determine the timeliness of these reports. The most common lag time of the reports was 2 weeks to 1 month (29.5%, 258/876) (Fig. 3). Despite the quantitative findings, study participants felt that there was timely reporting, ["*The timeliness of reporting for the province is more than 80%*" IDI10]. As for DHIS2 data entry at the province, VBDCP set a deadline that all data of a calendar month should be entered by four weeks of the following month, giving the provinces two extra weeks to enter the data from the date of receipt of data from the health centres (assuming data were submitted on time).

The FGD and IDI participants outlined many challenges to timely reporting. The use of physical reporting forms that needed to be transported to provincial offices meant that the remoteness of some health centres impeded timely reporting ["S*ome of the clinics are far like in the southern region, they could not do reporting on time*" FGD1]. A respondent in an IDI said, "*It's a bit hard because some clinics or health facilities … are remote…… far away so that's why the reports are coming in late*" [IDI2]. The MCMR report was ready in health centres but due to a lack of transportation facilities, they could not send the report to the provincial headquarters.

Other challenges included workload, inadequate infrastructure facilities such as separate offices, computers, uninterrupted internet access and communication systems to collect reports from geographically remote health facilities. The workload issues were raised by several respondents, [“*Yes, [because of] workload …. Sometimes they don’t have time [to submit the report]*” IDI8].

In addition, they had to input too many variables in the reporting forms, “…..*sometimes it is difficult to fill a variety of information into the form. … we found out [it] is time-consuming especially in the bigger health facilities”* FGD1]. Besides malaria, nurses were involved in reporting to other programs and had to use several reporting forms. Finally, a lack of regular supervision and feedback affected timely reporting [“*…. lack of feedback and supervision [means] we are not motivated to submit timely reporting*” FGD3].

Study participants suggested ways of improving timeliness of reporting. They suggested good transportation facilities are critical to timely reporting [“*We can improve the late reporting through improving transport*” IDI2]. In areas where the transportation facilities were erratic, it was proposed that the provincial supervisor officer could collect the reports by visiting these health centres. Communication technologies can enhance timely reporting, for instance, telephones can be used to collect reports from remote health centres. In some areas, they also used two-ways radio for communication. However, budgets often limited use of these communication methods.

Reliability

Information about the date of report submission, RDT and drug balance are not captured in DHIS2 despite these items being reported in the MCMR. The most reliable indicator in DHIS2 was ‘clinical malaria’ with 52.2% reliability followed by ‘*P. falciparum* diagnosed with microscopy’ at 48.4% reliability. The least reliable indicator was ‘*P. vivax* diagnosed with RDT’ at 29.9% reliability. Data from Malaita Province had higher reliability as compared to Honoria City Council. In Honoria City Council, the most reliable indicator was ‘clinical malaria’ at 67.6% reliability and the least reliable indicator was the ‘total tested with microscopy’ with 20.4% reliability. In Malaita Province, the most reliable indicator was ‘clinical malaria’ at 50.0% reliability and the least reliable was ‘*P. falciparum* diagnosed with RDT’ at 30.2% reliability (Table 4).

Table 4
Reliability of five indicators in DHIS2 as compared to paper records

Indicators*		Overall		HCC		MP	
		Number	%	Number	%	Number	%
Total parasites		334	38.1	38	35.2	296	38.5
PF	RDT	262	29.9	30	27.8	232	30.2
PV	MIC	424	48.4	44	40.7	380	49.5
Clinical malaria		457	52.2	73	67.6	384	50.0
Total test	MIC	361	41.2	22	20.4	339	44.1
Total test	RDT	296	33.8	24	22.2	272	34.4

* Three indicators namely report submission date, drug and RDT balance were not recorded in online DHIS2 database.

The interview respondents recognized that reliability of the malaria case reporting system meant that the data should be true, accurate and trusted. The data should be consistent with the other variables in the form as well as when matched with the different data sources (i.e. OPD registers and RDT and microscopy record books). Some respondents reported that there might have been some variance between the data sources, but this should be minimal ["*Of course there's a bit of variance there, which you have to expect. You never get 100%*"].

The respondents identified multiple challenges in reliability in malaria case reporting. Similar to availability and completeness, inadequate human resources affected data reliability. The local and tertiary-level health facilities were unable to verify or assess the quality of data ["*…unfortunately, the medical statistics unit doesn't have the human resources capacity. They have just four coordinators, even out of the four coordinators two have left- they are only left with one now*" IDI6]. Availability of adequate supervisory-level staff members was critical, particularly to assess data quality on a regular basis.

The respondents linked data reliability to the availability of adequate logistics. There were some facilities with a scarcity of tally sheets and reporting forms *["…when the forms run out, [we are] not able to submit the reports*" FGD2]. Another factor that affects the reliability of the data is programs frequently changing their forms, driven by donors who want to collect data on new indicators. Inadequate and inconsistent internet facilities were one of the main limitations of online DHIS2 reporting. Due to insufficient internet connectivity, the provincial surveillance office delayed entry of the data, leading to limited time to assess and verify the data.

The respondents made several recommendations to improve data reliability. Use of devices such as computers, mobile phones or tablets for data collection could address several reliability-related

challenges [“*…we don’t have computers and everything is manual that’s why it is challenging*” FGD3]. These devices would not only help in data collection but also enable the staff members to connect with their supervisors when they need instructions or guidance on reporting, especially when filling out forms. Arranging refresher training at regular intervals may help staff members to ensure quality data collection and reporting. Increased use of the DHIS2 data system could help in improving data reliability. For example, if data from the system were used for policy decision making regularly by government authorities, errors would be more likely to be identified and fixed, with an increased investment to ensure adequate human resources, infrastructure and facilities. A respondent in an IDI said, “*The best way to improve reliability is to improve the demand for their time. The more the data is used the more issues that they will encounter with the data, the more ways you will find out to actually fix these issues”* [IDI6].

Discussion

We identified significant performance issues with the malaria case reporting system in Solomon Islands. Notably, the completeness of data ranged from 38.5–90.3% and only 5.1% of reports were submitted on time (i.e. before the 15th of the subsequent month). The highest percentage of reliability for any indicator was only 62.4%. The main challenges for completeness were a lack of supervision, limited feedback, inadequate human resources, a lack of training and refresher courses and the high workload burden associated with case-based reporting. Enablers of improved system performance would include regular supervisory visits and training and provision of computers for recording data at the health centres. Challenges of timeliness were the remote locations of some health centres, a lack of regular transportation, inadequate human resources and too many variables in the reporting forms. These challenges can be addressed by the use of alternative communication technologies such as phones and two-way radio. The main challenges to reliability were a lack of trained technical professionals such as statisticians, donor-driven data collection forms, and unavailability of items such as tally sheet and reporting forms. This can be addressed through training, and provision of computers, mobile phones or tablets for data collection.

Computerisation of data collection, analysis and data transfer is often offered as the answer to health information problems. This was consistently highlighted in our study where study participants recommended moving from a paper-based system to technology-based data recording and reporting. The benefits of using such technologies can be obtained at different levels of health systems. In health centres, they can help in reducing the workload, and improve data collection and reporting [24]. At the district, provincial and national level, they can enhance monitoring, supportive supervision and feedback [24]. However, upate of technology-based recording and reporting are hampared by lack of awareness and organizational support [25, 26]. Other barriers include internet coverage [27] and electricity [28], limited budgets for system introduction, maintainence and repair of devices [29–31] and limited training of personnel in their use [32, 33]. The expansion of computerised recording and reporting in Solomon Islands need to address these barriers for expanding it to the health centres.

Notably, the completeness of reporting in this study was better than findings from Kenya and Nigeria [15, 34]. The latter two studies were conducted in settings with more intensive transmission and where public health programmes focus on malaria control rather than elimination. In Solomon Islands, transmission is more focal and case-based reporting is done to help achieve the goal of malaria elimination [35]. In elimination settings, data completeness is particularly important, as the system needs to identify all cases of malaria.

Completeness was less than 50% for reporting of anti-malarial drugs and RDTs in the health centres. This is concerning because health centres in Solomon Islands are located in remote areas with limited transportation. These indicators are important because they help prevent running out of drugs and RDTs in hard-to-reach health centres. Therefore, it is important to take measures to increase the completeness of these two useful indicators. Completeness of reporting can be increased through the provision of additional training, in the form of refresher courses, as suggested by participants in this and other studies [15]. Another area that needs urgent attention both at the level of health centres and provinces pertains to the shortage of human resources. This will require long-term planning and investment.

The national policy of the Ministry of Health and Medical Services of Solomon Islands requires all health centres to submit their monthly report to the provincial health centre within two weeks, defined as the 15th day of the subsequent month. Most of the participants understood this timeline of report submission. However, only 5.1% of cases were reported within the reporting time and 36.2% did not have the submission date recorded on the forms. This is much lower than a report from Uganda, where timeliness of outpatient reporting was 22.4% in 2011–2012 and increased to 85.3% in 2012–2013 [36]. Among other reasons, the current system is a two-tier system of paper-based reporting and entry into the electronic DHIS2 database, which seems to be impacting on timely reporting. Zambia has expanded reporting from health centres directly into DHIS2 using telephones [37]. Other studies have shown that telephones can be an effective tool for submitting reports in near real-time [38]. Unlike other programs such as for tuberculosis, acute respiratory infections and immunization that involve aggregated reporting, the malaria program in Solomon Islands uses case-based reporting. This requires considerable time for data extraction from registers such as OPD, microscopy, RDT and stock registers. As a result, there were occasions where other program reports (which involved aggregate reporting) arrived on time while malaria reports were submitted late. The reporting time could be extended from the 15th to the 30th of the subsequent month as a more realistic timeline, although this will result in delays in identifying emerging patterns of malaria. Alternatively, data entry into DHIS2 using phones or computers could be extended to health centres.

In most developing countries, the process of collection, collation, compilation, analysis and reporting of health care data is limited by inadequate human resources- both in terms of skills and required numbers. Additionally, a lack of data ownership compounded by health workers' perception that the purpose of a HIS is simply to enable submission of reports to the higher levels, leads to a situation where there is no incentive for health workers at levels below the national level to analyse, use and interpret health data [13, 18, 39]. This results in poor quality data, as identified in our study and other studies in developing

countries [40, 41]. However, reliable information when generated by manual or technological systems is important for quality decision making, which ultimately leads to improved quality of care [42]. Conversely, inaccurate information can lead to poor choices in health investments. Regular feedback to the health centre is also important in improving the quality of data [40, 43]. Feedback is a form of training and directly addresses the causes of poor quality data and enhances awareness of the importance of data. However, a lack of regular feedback from the province to the health centres occurred in our study, which was due to inadequate human resources at the province level. The government of Solomon Islands needs to address this issue in earnest.

Some of the problems highlighted above can be addressed by supporting electronic data capture from health centres [44]. The formerly used SDSS was successful in enabling the digital capture of data from remote parts of Solomon Islands [5–7]. However, the SDSS could not be sustained because it was not integrated into the national surveillance system. Extension of data entry to health centres is now possible with the DHIS2 enhanced system [45, 46] because DHIS2 has developed an android app which allows for an offline data entry [47]. More work needs to be done to explore this and other technological solutions for improving DHIS2 applications for malaria and other infectious diseases.

Limitations and strengths of the study

This study is subjected to a number of limitations and strengths. First, this study was undertaken in two provinces and the Honiara City Council, and the findings may not represent those of other provinces or the national situation. Second, the non-random sampling of study sites limits our ability to generalize the results more widely. Thirdly, resources were not available for double extraction and double-entry when extracting data from the MCMR forms. Finally, this study was conducted in the second year of DHIS2 implementation and the reporting may have improved since then. The FGDs and IDIs were conducted in one field trip and we did not have the opportunity to review the interview approach to identify gaps and then refine the approach in subsequent interviews. Additionally, we were unable to assess data saturation during data collection that may enable measurement of the richness of the qualitative findings. Failure to reach data saturation may have hampered content validity [48]. Despite these limitations, a major strength of the study was the use of multiple data sources to clarify each of the main themes. This provided a richness of information which, upon analysis within and across the data sources, enabled the discovery of a number of consistencies as well as diversity in the findings.

Conclusion

The availability, completeness, timeliness and reliability of nine malaria indicators collected in DHIS2 were variable within the two study sites where this information was available but generally low. Extension of electronic data capture to health centres would improve the timeliness, completeness and reliability of reporting. Continued onsite support, supervision, feedback and additional system (especially infrastructure) enhancements such computers will be required to further increase completeness and reliability of the reports.

Declarations

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Authors' contributions

KW, ACAC and EM conceived the study. KW undertook a literature review, fieldwork, analysed and drafted the manuscript. JL assisted in fieldwork and HS assisted in analysis. ACAC was involved in the critical revision of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Data are available upon reasonable request by an email to the corresponding author.

Ethics approval and consent to participate

Ethical approval for this study was provided by the Solomon Islands Research Ethics Review, Ministry of Health & Medical Services (No: HRE064/17) and the Human Research Ethics Committee of James Cook University (Application ID: H7214). Administrative permissions were obtained from the Directors of Honoria, Malaita and Guadalcanal Provincial Health Services. The interviewer explained the general-purpose, benefits and any risks of the survey to each respondent. Respondents had the right to refuse participation in the survey at any point. Confidentiality was maintained at all times during the conduct of the interviews.

Consent for publication

All authors have given their consent for this publication.

Conflict of interest

Authors declare no conflict of interest.

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Figures

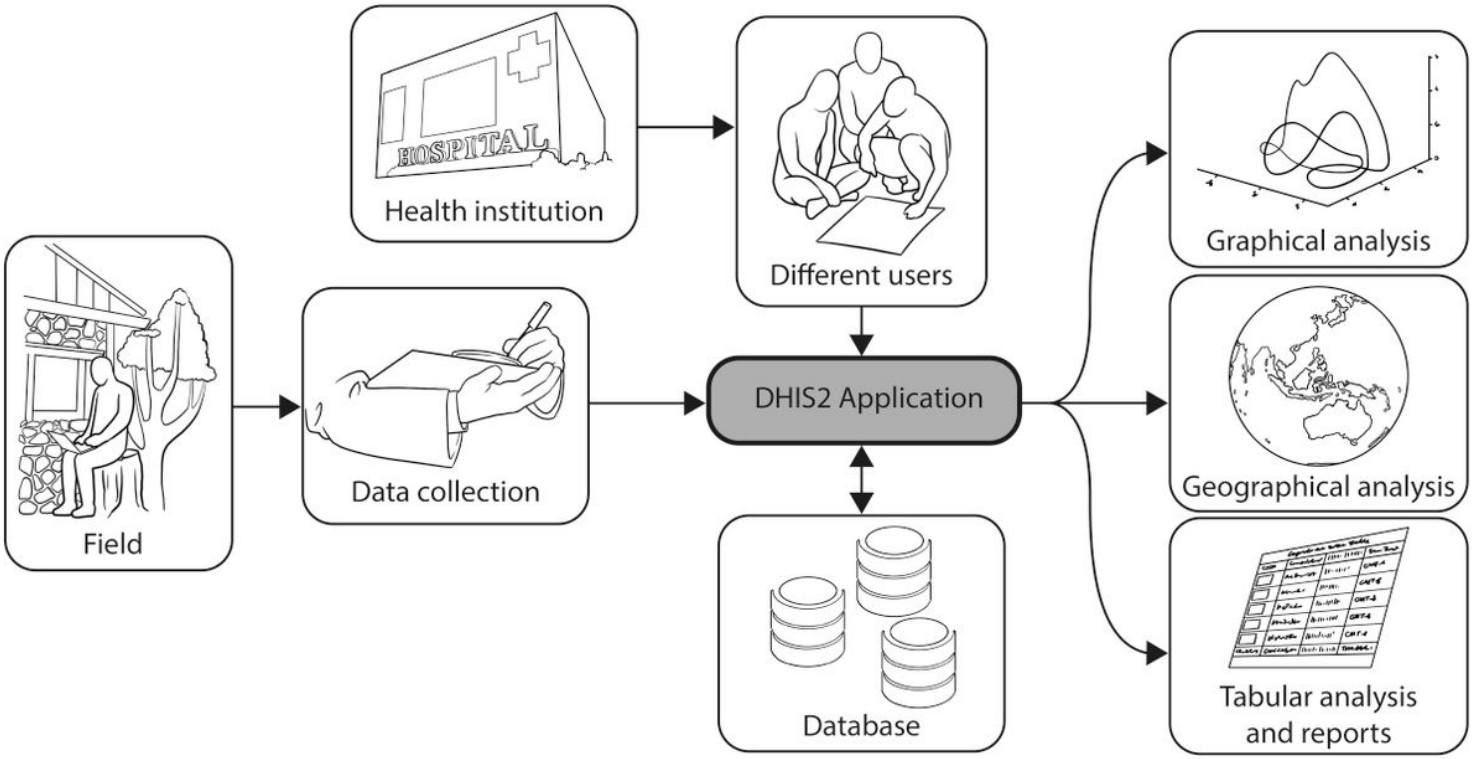

Figure 1

The functionality of District Health Information System 2.

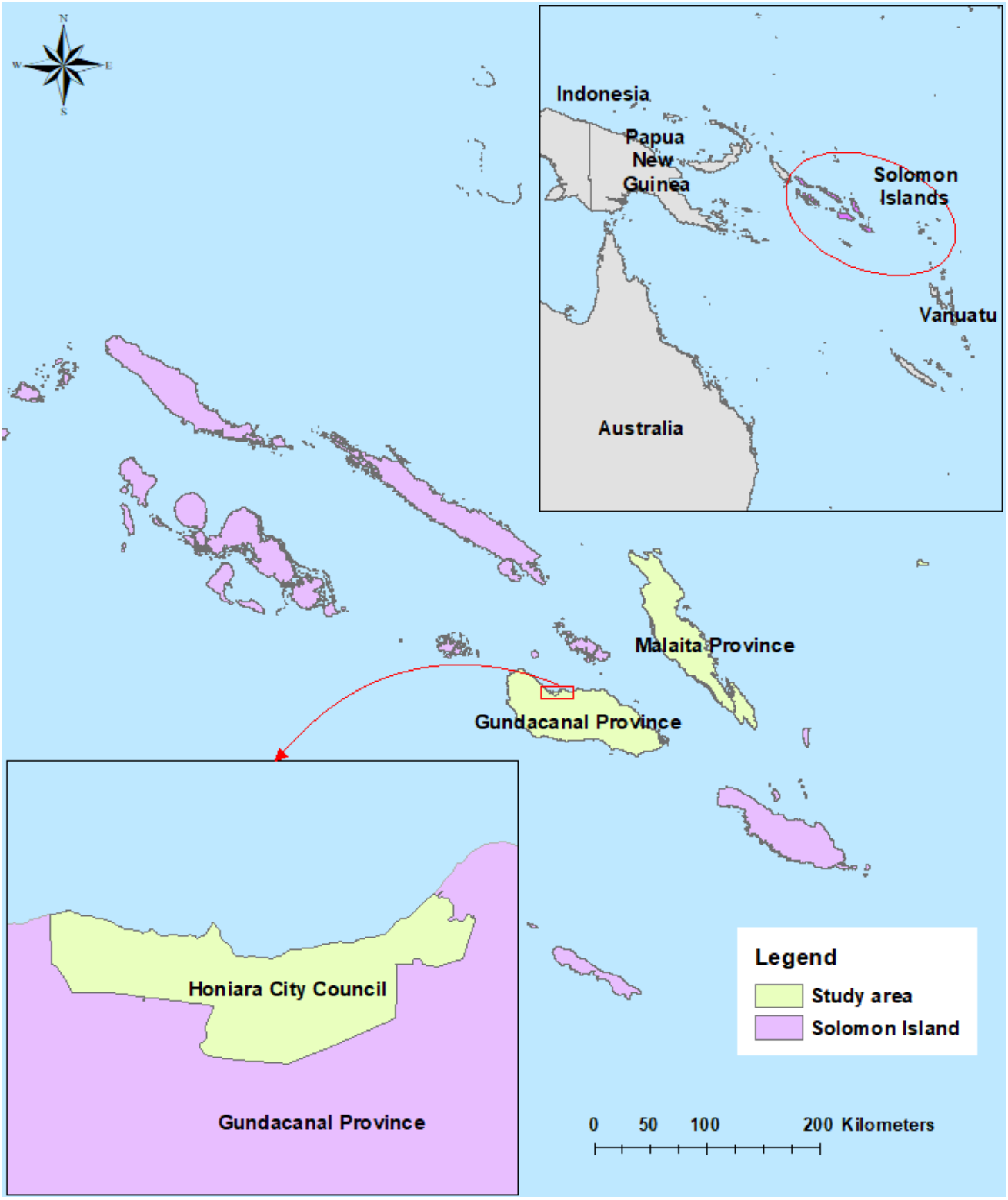

Figure 2

Map of Solomon Islands with study three study areas.

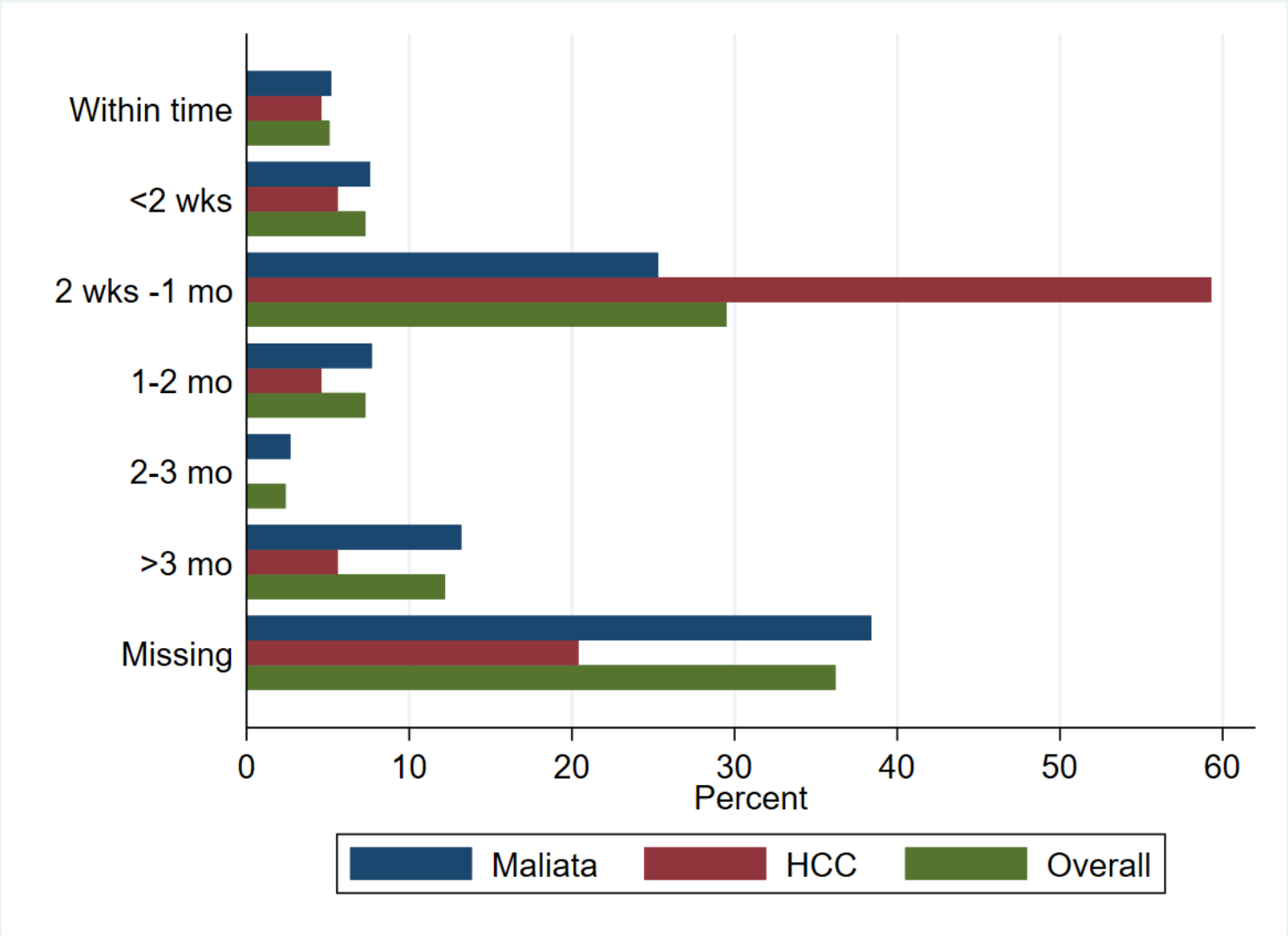

Figure 3

Timeliness of reporting from malaria clinics to the provincial information office of Malaita province, HCC and overall. Note: HCC- Honiara City Council