# Enhancing the routine health information system in rural southern Tanzania: successes, challenges and lessons learned.

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## Authorship Agreement

The paper was drafted by BW, WM, JAS and DS. BW carried out the statistical analyses, with support from JAS. DS, JAS, HM, PA and MT participated in the set up and management of the Morbidity Monitoring study. WM, KS and MC were responsible for data collection. All authors commented on drafts of the paper and approved the final version.

**MESH keywords:**

Malaria; Tanzania; program evaluation; management information systems; computers, handheld.

**Abstract word count:** 249

**Manuscript word count:** 4112

**Abstract:**

Introduction

Health Management Information System (HMIS) data are used for the management of health systems, monitoring of health policy performance, and outcome evaluation. HMIS data collection in developing countries is often manual; we describe the use of hand-held computers to enhance this process.

Methods

Electronic data capture took place in 11 sentinel health centres in rural southern Tanzania. Information from children attending the Outpatient Department (OPD) and the Expanded Program on Immunization vaccination clinic was captured by trained local school-leavers, supported by monthly supervision visits. Clinical data included malaria blood slides and hemoglobin colour scale results. Quality of captured data was assessed using double data entry. Malaria blood slide results from health centre laboratories were compared to those from the study's quality controlled laboratory.

Results

The system took five months to implement, and few staffing or logistical problems were encountered. Over the following 12 months (April 2006-March 2007), 7056 attendances were recorded in 9880 infants aged 2-11 months, 50% with clinical malaria. Monthly supervision visits highlighted incomplete recording of information between OPD and laboratory records, where on average 40% of laboratory visits were missing a record of their corresponding OPD visit. Quality of microscopy from health facility laboratories was lower overall than that from the quality assurance laboratory.

Conclusions

Electronic capture of HMIS data was rapidly and successfully implemented in this resource-poor setting. Electronic capture alone did not resolve issues of data completeness, accuracy and reliability, which are essential for management, monitoring and evaluation; suggestions to monitor and improve data quality are made.

**Introduction:**

The importance of well-functioning Health Management Information System (HMIS) has been emphasised by the World Health Organisation (World Health Organisation, 2008). It enables adequate planning by health managers, and provides a framework within which the performance of the health system and that of intervention programmes, including malaria control programmes, may be evaluated.

In many countries in Africa, including Tanzania, the HMIS depends on manual data collection; a time-consuming method that overburdens health staff, is prone to error, and hampers summary and rapid retrieval of information. These shortcomings may produce unreliable information that can lead to planning inefficiency, resource wastage, and inappropriate resource allocation at regional or national levels (Azubuike and Ehiri, 1999). In comparison to manual data collection, the use of an electronic HMIS is reported to be more accurate, less time-consuming, and shows a high level of acceptability among health staff (Ndira et al., 2008).

In this paper we describe the experience of the use of hand-held computers (Personal Digital Assistants; PDAs) to collect routine information from the Outpatient Department (OPD), laboratory, and Reproductive and Child Health (RCH) vaccination clinics of 11 sentinel health centres in five rural districts of southern Tanzania (figure 1). We (i) detail the implementation of this electronic data capture; (ii) document the training and supervision of PDA operators and health centre staff; (iii) describe temporal trends in data completeness and timeliness; and (iv), in order to assess the feasibility of using HMIS laboratory data to provide reliable estimates of parasitologically-confirmed malaria cases, report the quality of malaria blood slide microscopy in the health centre laboratories in comparison to that of a quality assurance (QA) laboratory.

**Methods:**

*Study area and the existing HMIS:*

The enhanced HMIS data collection and morbidity monitoring described took place in the context of a cluster-randomized control trial of Intermittent Preventive Treatment for malaria in infants (IPTi), assessed by household surveys and a community census, and health centre surveys (Armstrong Schellenberg JRM, 2010). Additionally, in a Morbidity Monitoring sub study, HMIS data from 11 sentinel health centres were used to document feasibility of the delivery of IPTi through routine contacts with the health service, and evaluate effectiveness of IPTi.

The area has been described in detail (Armstrong Schellenberg et al., 2008). Briefly malaria is endemic, with transmission occurring throughout the year, and is the most common primary cause of health centre or hospital admission among those aged under five years. The health system in the study area consists of 168 facilities including hospitals (n=6), health centres (n=13), and dispensaries (n=149). Health centres on the whole have laboratory diagnostic facilities and are staffed by trained nurses, clinical officers, and assistant medical officers. Health planning in Tanzania is decentralized to the districts and the District Health Management Team, headed by the District Medical Officer, is empowered to plan and allocate resources. The Tanzanian HMIS consists of 12 registers; including one for OPD attendees, and another for infants attending the Expanded Program on Immunization (EPI) at RCH clinics. The OPD register records date of consultation, diagnoses and treatments given, but not symptoms, while the EPI register records dates and doses of routine immunizations. Separate registers for different laboratory investigations are used, but these are not included in the routine HMIS. At the RCH clinics, when infants attend for routine immunizations or weighing sessions, information on immunizations, body weight and growth are recorded on the child's health card, which contains some demographic information documented at birth. Mothers or carers are expected to bring the child's health card to all RCH, immunization and OPD appointments and visits.

*Enhancement of the HMIS:*
As an enhancement to the existing HMIS system, we established a PDA-based system in all health centres with on-site functional microscopes in the study area (11/13 centres). Implementation of this Morbidity Monitoring study was staggered, beginning in 2005, and data collection ran until January 2008. A period of full functionality was defined as 12 months between April 2006 and March 2007, and results refer to this period.

*Identification codes:*
Children aged less than five years were registered when they visited the selected health centre for sickness or for routine RCH visits, including EPI immunization visits. Each registered child was given a 12 digit Identity Code (IDC) during registration to enable linkage of an individual between the separate registers (OPD attendance, laboratory results, and EPI vaccinations), and between subsequent visits made by the same child. The IDC was created by combining the first two letters of the child's first name, the first letter of the mother's and father's first names, the month and year of the child's date of birth, the first three letters of the area of residence, and finally either number 1 (singleton or first twin), 2 (second twin or triplet), or 3 (third triplet). The generated IDC was written on the child's RCH card and an extra column next to the child's name was added to the end of each page in the OPD, laboratory and immunization registers, in which the IDC could be added at each clinic visit. During monthly supervision visits, IDCs electronically entered were compared with details on paper records to ensure accuracy in data entry.

*Personal Digital Assistants operators and software:*
PDA operators were selected by posting advertisements in villages surrounding the health centres. Applications from secondary school-leavers, who were residents of neighbouring villages, and experienced in using mobile telephones for text messaging, were considered. In each health centre three candidates were shortlisted and underwent a three day training course led by the study data manager (KS) and data entry clerk, which included a data entry exercise using dummy-filled RCH cards. Based on performance during training, one of the three candidates was selected to be the PDA operator for the health centre. Supervision and support of PDA operators continued on a monthly basis throughout the study when the study data manager (KS) or data entry clerk observed the PDA operators while capturing data in their respective health centers. Summary reports of time and date patterns of data entry were automatically generated during PDA use, and results of these reports were discussed with PDA operators during supervision visits to emphasise the importance of timely data capture, and to encourage good data entry practices.

Full details of PDA hard and software are provided elsewhere (Shirima et al., 2007). In brief we use Palm m130 (Palm Inc, Sunnyvale, CA 94085, USA) units with a coloured touch-sensitive screen, powered by a rechargeable internal lithium ion battery that lasted for at least two working days (recharged by solar power). Pendragon Forms 4.0 (Pendragon Software Corporation, Libertyville, IL 60048, USA) software was used, which allowed logical checks to be attached to questions, and the use automated of skip patterns. Drop down menus of the most frequently used treatment and diagnosis categories were created for use by the PDA operators. Data from each register were entered separately, but linked by the unique IDC. Data were downloaded from the PDA to an IBM ThinkPad laptop (IBM Corporation, Armonk, New York 10504-1722, USA) using synchronising software provided with the PDAs (Palm TM Desktop for Microsoft Windows 4.0.1), and subsequently backed up onto CDs.

*Health centre staff familiarisation, monthly health centre visits and health centre reports:*
Staff at health centres received a week's on-the-job training at their health centre, conducted by the study's Medical Officer (WM), data manager (KS), data entry clerk, and an experienced

laboratory assistant. Health centre clinicians received training for completion of OPD register and re-generation of IDCs. Local laboratory personnel received training for malaria blood slide staining using Giemsa stain (Warhurst and Williams, 1996), classification of parasite positive blood slides (?1 parasite/200 white blood cells (WBCs)) (Warhurst and Williams, 1996, O'Meara et al., 2006), hemoglobin analysis using the hemoglobin color scale (Gosling et al., 2000), storage of malaria blood slides, as well as recording of malaria blood slide and hemoglobin results in the register.

Monthly supervision visits to all study sites were carried out by the study co-coordinator (WM), data manager (KS), and laboratory assistant. At this time, data from PDAs were synchronized with the study's dedicated laptop and backed up onto CDs, stored blood slides were collected, and laboratory and other project supplies were delivered. As described above, during supervision visits IDCs on PDAs were cross checked with details recorded in HMIS ledgers, and patterns of data entry were discussed with PDA operators. Visits were also an opportunity to discuss issues of data completeness and quality with health centre staff. The basis for these discussions was the automatically-generated monthly report (figure 2). These compared numbers of OPD attendances and EPI vaccinations to those recorded during the previous month; highlighted whether all OPD attendances had corresponding laboratory records; and listed the top ten diagnoses made at the centre in the past month, which previously had been prepared manually.

*Double data entry and laboratory blood slide microscopy quality control:*
Each PDA operator was working full-time in one of the 11 health centres. They were supported by the study's data entry clerk who visited each health centre monthly throughout the study, and completed double data entry for all data from OPD attendance and laboratory registers. Discrepant entries between those of the PDA operator and the study's entry clerk were identified, and a third independent person identified the definitive data, by referring back to the original paper registers.

Blood slides for malaria parasites were initially read on-site in the health centre laboratory, except for one health centre (centre D) where the qualified laboratory personnel left shortly after introduction of our system. In this health centre, blood slides were stained and stored, without reading. Blood slides from all 11 centres were then read twice by two independent slide readers in the Morbidity Monitoring study's QA laboratory. Parasite densities per 200 WBCs were counted, and if results were discrepant, a third slide reading was performed. Results were defined as discrepant if one was positive and one negative, or if the ratio of the difference in parasite density between two positive readings was greater than 1.5 or less than 0.67. When a third reading was necessary, because of density discordance, the geometric mean of the three readings was used as the definitive blood slide result (Alonso et al., 1994, O'Meara et al., 2005).

*Statistical analysis:*
Data from PDAs were exported from Pendragon Forms software to Microsoft Access for data management, and subsequently to Stata for statistical analysis. Stata 10.1 (Stata Corp., College Station, TX, USA) was used to calculate proportions, incidence rates, confidence intervals, and relevant p values in infants aged 2-11 months presenting during the period from 01 April 2006 to 31 March 2007. Blood slide malaria results between the health centre laboratories and the QA laboratory (gold standard) were investigated using calculated sensitivity (true positives/ true positives + false negative) and specificity (true negatives/ true positives + false positives), percentage positive for each laboratory, percentage agreement, as well as Cohen's Kappa score (Cohen, 1960), and degree of agreement above that expected by chance alone followed the classification suggested by Koch and Landis (Landis and Koch, 1977).

*Ethical clearance:*

The study was undertaken within the framework of the assessment of the community effectiveness of IPTi, part of the IPTi Consortium (Schellenberg et al., 2006). We received ethical approval from the following local and national institutional review boards: Ifakara Health Institute, National Tanzania Medical Research Coordinating Committee, London School of Hygiene & Tropical Medicine, and the Ethics Commission of the Cantons of Basel-Stadt and Basel-Land, Switzerland. The permission to execute the project was sought and obtained from the Tanzania Ministry of Health and Social Welfare and the respective District Councils of the participating districts.

**Results:**

*Implementation:*

It took five months to establish the Morbidity Monitoring framework in all 11 health centres in the study area. Few logistical problems were encountered during implementation, mainly as this methodology and technology had been previously used in a household survey in Tanzania (Shirima et al., 2007). For example, solar energy was used to power PDAs, reducing the impact of power cuts to the health centres, and no serious problems with PDA hardware or software were experienced. An initial equipment outlay of US $480 per health centre was required, including about US $100 per PDA unit. Running costs were estimated at approximately US $7800 per health centre per year, with over 60% of these costs due to personnel, principally supervision personnel. All but one of the 11 PDA operators who completed training remained with the project for the duration of the study. A new PDA operator was recruited and trained six months into the study to replace one who was performing poorly.

The use of IDCs was successful at uniquely identifying infants, with 0.08% duplication on average across all 11 health centres in infants aged 2-11 months (attending between April 2006 and March 2007). Although the IDC was constructed with the aim of being easily re-generated for occasions when the child health card was forgotten, in practice IDCs were rarely re-generated by health staff, and parents had difficulty recalling the information needed for the IDC.

*Data entry:*

The use of the drop down menus for treatment and diagnosis details within the PDA software were not well-used by PDA operators. Instead treatment and diagnosis details were entered manually, resulting in many spelling variations and some incomprehensible entries. For example, prior to data cleaning 1889 categories were included in the treatment variable, with 2053 in the diagnosis variable, which was reduced to 109 individual (i.e. ungrouped) categories for treatment, and 222 for diagnosis respectively after data cleaning and management were completed.

Double data entry was performed on all records from the OPD and laboratory registers, and discrepant entries were corrected. In total 19% of entries from the laboratory register were discrepant, with errors in the spelling of the child's name (54%), and in failure to count WBCs (33%) being the most frequent. Almost 73% of entries from the OPD attendance register were discrepant. Again most were due to errors in the spelling of the child's name (23%), spelling of treatment (17%), and spelling of diagnosis (10%) variables.

*Data completeness and timeliness:*

During the year April 2006 to March 2007, a total of 7056 OPD attendances, and 5246 blood slides were recorded in 9880 infants aged 2-11 months, with an incidence of OPD attendance of about 2/infant/year. A malaria diagnosis was recorded in 50% of OPD visits, with an incidence of about 1/infant/year (table 1)[1].

Feedback to health centre staff during supervision visits emphasised that data completeness between OPD and laboratory ledgers was important. The number of OPD attendees without laboratory records was monitored and changed little over time remaining at about 44% (average for all 11 centres). A more appropriate measure of data completeness may be the number of malaria diagnoses without a laboratory result, although it is important to note that MoH guidelines at the time of this study did not include parasitological confirmation of clinical malaria cases before treatment, as is currently the case (World Health Organisation, 2010). Of visits with a clinical malaria diagnosis recorded (n=3553), 54% had a corresponding blood slide result available from the health centre laboratory. Availability of blood slide results showed wide variability by health centre (range 14%-93%) (table 1).

An additional measure of data completeness, not assessed during monthly supervision visits, is the proportion of health centre blood slide results without a corresponding OPD record- termed orphan slides. On average, 41% of blood slide readings were lacking a corresponding OPD record suggesting incomplete data recording, which showed variability by health centre (59% to 24% orphan slides) (table 2).

Feedback to PDA operators from the monitoring of time and motion activity of the PDA operator by study staff during supervision visits was useful and showed improvement in timeliness of data entry, for example, using an average across all 11 centres, the proportion of records entered on the same day as attendance at the health centre improved from 67% to 85%. Information on timeliness of data transfer from the periphery to the district was not available. Additionally this study did not explicitly monitor use of electronically captured HMIS data to modify health care practices. The only proxy measure of change in practices available- the number of OPV and DPT vaccines administered at two months (which should be equal to one another, in line with EPI scheduling guidelines)- changed by only 1%, albeit from a high baseline, from 94% to 95%.

*Quality of malaria microscopy:*
The sample size available for investigating the agreement between the blood slide results from the health centre and the QA laboratory was 5166 (table 3). In comparison with the QA laboratory, the health facility blood slide results had a sensitivity of 89.6% and a specificity of 77.3% overall, though this varied by health centre with sensitivity ranging from 53.5-99.3% and specificity from 21.9-95.3%. Overall, a kappa score of 0.572 was documented, suggesting moderate agreement above that expected by chance alone between the health centre laboratory blood slide results and those from the QA laboratory, although this ranged between 0.865, suggesting almost perfect agreement above that expected by chance alone, and 0.098, suggesting slight agreement above that expected by chance alone (table 3).

**Discussion:**
We have described the implementation of electronic data capture from the Health Management Information System in rural southern Tanzanian. Data from 11 sentinel health centres were collected by minimally-trained local secondary school-leavers who were externally-supervised on a monthly basis. Few serious logistic or staff problems were encountered, and use of this technology resulted in easily-produced monthly summary reports of patient information and morbidity trends.

Challenges with using this methodology include the creation and use of an individually unique identification code, which can be re-generated. The creation of identification codes is challenging in settings like Tanzania, which often lack national identity numbers, and where birth dates may be inaccurate, and name spellings flexible. The IDC used in this study reliably, though not perfectly, produced a means for uniquely identifying individuals, but proved to be re-generated much less frequently than anticipated. Additional program design challenges include the need for more robust data entry for variables such as treatment and diagnosis, which could be addressed though piloting to determine frequently-used categories, and PDA operator training to accurately allocate treatments and diagnoses to appropriate categories. The nature of errors detected during double data entry, principally spelling errors in names, and diagnosis and treatment variables, also highlight the necessity of unique IDCs, and drop down menus for variables that may be easily misspelled:. Improvements in technology since 2005 are likely to go some way to helping resolve such programming issues.

The use of HMIS data for monitoring programme effectiveness, and evaluating the effectiveness

and safety of interventions has been much emphasised (WHO Roll Back Malaria, 2000, WHO Roll Back Malaria Monitoring and Evaluation Reference Group, 2005). The implementation and running of this study highlighted the importance of quality control, monitoring and feedback. Results from the double data entry of HMIS data (OPD and laboratory registers) emphasise the usefulness of this technique for detecting errors (World Health Organisation, 2008). Results also suggest that complete data recording between different registers, and high agreement between health centre and control laboratories may be used as quality control indicators of health centre functioning in settings similar to those seen in Tanzania.

Over 40% of health centre laboratory results from these rural health centres were not recorded in the OPD register (orphan slides). A total of 35% of these orphan blood slide results came from the two largest and busiest centres, which saw almost 25% of OPD visits. One health centre, with few OPD visits, but very high levels of orphan slides, experienced serious laboratory staffing difficulties. We hypothesise that if this measure evaluating complete data recording had been explicitly monitored during data collection, and discussed during monthly feedback with health centre staff as with other data completeness and timeliness variables, outcomes may have improved following constructive feedback to and support for staff on the importance of accurate and complete HMIS data collection.

National Tanzanian guidelines for diagnosis and treatment of malaria from 2006 recommend the performance of a malaria test in facilities with laboratory services, while the algorithm for a child aged less than five years presenting with fever (based on WHO's Integrated Management of Childhood Illness) recommend treatment with the first line anti-malarial drug (National Malaria Control Programme, 2006). Therefore the observation that over half of clinical malaria diagnoses had a corresponding blood slide result available from the health centre laboratory, but that this showed wide variability, is not unexpected. The revised WHO global malaria program treatment guidelines recommend parasitological diagnosis before treatment of all malaria cases, regardless of age (World Health Organisation, 2010). This clear recommendation is likely to facilitate the completeness of laboratory blood slide results in consolidated health information systems such as the one described here.

Quality control results for malaria blood slide readings showed that there was wide variability in sensitivity and specificity of health centre laboratory microscopy results in comparison to expert microscopy in the quality assurance laboratory, and that levels of false positives (identified as parasite positive on slides in the health centre, but negative by expert microscopy - specificity) were higher than false negatives (sensitivity). There was generally only moderate agreement above that expected by chance alone between the results obtained in sentinel health centre laboratories and those from the QA laboratory, suggesting that health centre classification of parasitologically-confirmed malaria cases was not reliable. This demonstrates that, although a few health centre laboratories performed well, good quality blood slide microscopy at peripheral health facilities cannot be guaranteed even with considerable investment in training and supervision. The introduction of Rapid Diagnostic Tests should help to improve the availability of reliable parasitological pre-treatment malaria diagnosis, in line with new WHO guidelines (World Health Organisation, 2010).

The use of PDAs to enhance HMIS data capture in this study occurred in the context of monitoring IPTi implementation and evaluating the effectiveness of this malaria control intervention. Electronic HMIS data capture was not introduced to health centre staff in peripheral facilities of southern Tanzania, and this study did not explicitly monitor interaction of external PDA operators with health centre staff, sustainability of this form of data capture in this setting, or transferability of training applied to PDA operators for use by health centre staff. Nonetheless,

anecdotal reports from project managers (WM, MC and KS) suggests that interactions were positive: PDA operators assisted health staff in various duties including weighing children, plotting their growth on the child health cards; and some health centre staff learned to operate PDAs out of their own interest, with very informal training. Project managers are of the opinion that training would be easily transferrable to health centre staff, and that introducing PDA-based data capture may be easier for health workers as they are more likely to understand medical terminology used- such a diagnostic and drug information. Acceptance of PDAs has also been monitored and documented in the same geographical area in the context of large household surveys (Shirima et al., 2007).

Electronic capture of data by methods such as the use of PDAs may be efficient, provide data in a format that is flexible and easy to summarise, and may help to highlight incompleteness of data though regular monitoring. However, this study shows that supervision, and monitoring of data quality and completeness are essential. Therefore, although this method of HMIS data collection has the potential to minimise health staff data entry and manipulation workload, incorporation of supervision of PDA-based data capture by health centre staff within current routine supervision is unlikely to function efficiently. Therefore, although the cost of PDA units themselves are reasonable, at about US $100 per unit (2005 price)- and likely to be lower still in 2011, with improved processing power, personnel costs, and costs of external supervision in particular, are likely to make this system unaffordable and impractical on a large scale.

In addition, use of this technology alone will not resolve underlying issues of quality and completeness of data, which are crucial to produce information that can be used for monitoring and evaluation of health systems, policies and interventions (WHO Roll Back Malaria, 2000, Rowe et al., 2009), and can in turn influence resource allocation and policy. Improving data quality and completeness requires evaluation of HMIS performance, and strengthening of processes. Toolkits to this end exist, such as PRISM (Performance of Routine Information System Management) developed by MEASURE Evaluate/USAID (Aqil et al., 2009). PRISM consists of a conceptual framework and tools that focus on behavioural, technical and organizational determinants, and has been used in Uganda (Aqil, 2004) and Cote d'Ivoire (Gnassou et al., 2008)- a similar approach may be useful in Tanzania.

**Acknowledgements:**
We would like to thank health staff in the sentinel health centres, PDA operators, and Regional and District Health Management Teams of the participating regions and districts. We appreciate the cooperation offered by the Tanzania Ministry of Health and Social Welfare, and the administrative support given by the Ifakara Health Institute. This study was financially supported by the Bill and Melinda Gates Foundation through the IPTi consortium. JAS was supported by funding from Gates Malaria Partnership, and JAS and BW are members of the MRC Tropical Epidemiology Group at the London School of Hygiene & Tropical Medicine. Finally, our thanks are also due to the anonymous TMIH reviewers for their helpful comments.

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Figure 1: Study area in southern Tanzania (Lindi Rural, Ruangwa, Nachingwea, Tandahimba and Newala districts), showing sentinel health centres included in the Morbidity Monitoring study

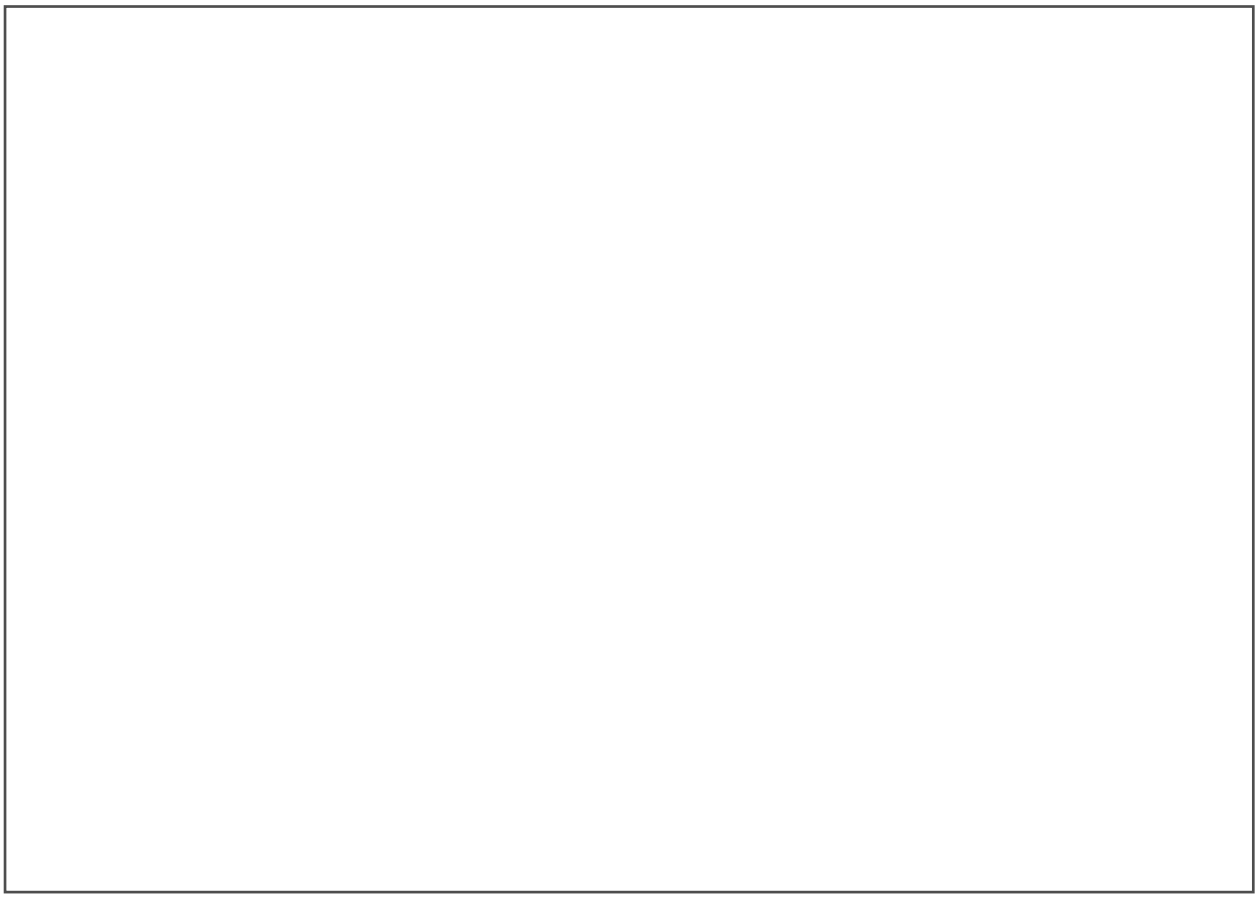

Figure 2: Example of an electronically-generated monthly health centre summary report

IPTi in southern Tanzania

# Summary Report for Health Centre
## As Of August, 2006

IHRC

Site Start Date: Thursday, 03 November 2005

### 1. OPD SUMMARY

| | No. Under 5 | No. Under 1 | % Under 1 |
|---|---|---|---|
| Total No. of children registered | 1925 | 741 | 38.49% |
| No. of children registered previous month | 71 | 38 | 53.52% |
| No. of children registered during the month | 79 | 49 | 62.03% |
| Total No. records in OPD | 1432 | 1079 | 75.35% |
| No. of records in OPD previous month | 136 | 104 | 76.47% |
| No. of records in OPD during the month | 131 | 93 | 70.99% |

| TOP TEN DIAGNOSIS | Diagnosis | Cases | |
|---|---|---|---|
| Under 5 Years | Malaria | 69 | 54% |
| | Diarrhoea | 20 | 16% |
| | G/ENTERITIS | 11 | 9% |
| | ARI | 8 | 6% |
| | Bronchitis | 6 | 5% |
| | Asthma | 3 | 2% |
| | Scabies | 3 | 2% |
| | ENTERITIS | 3 | 2% |
| | WOUND | 3 | 2% |
| | CELLULITIS | 2 | 2% |
| Under 1 Year | Malaria | 31 | 46% |
| | Diarrhoea | 16 | 24% |
| | ARI | 6 | 9% |
| | G/ENTERITIS | 4 | 6% |
| | Bronchitis | 4 | 6% |
| | ENTERITIS | 2 | 3% |
| | ULCER | 1 | 1% |
| | Pneumonia | 1 | 1% |
| | LRTI | 1 | 1% |
| | INFECTION | 1 | 1% |

### 2. LABORATORY SUMMARY

| | No. Under 5 | No. Under 1 | % Under 1 |
|---|---|---|---|
| Total No. of records in laboratory | 1075 | 428 | 39.81% |
| No. of records in laboratory previous month | 91 | 33 | 36.26% |
| No. of records in laboratory during the month | 88 | 41 | 46.59% |
| No. of blood slides taken during the month | 88 | 41 | 46.59% |
| No. of positive (+) blood slides | 36 | 10 | 27.78% |
| No. of positive (+) blood slides | 52 | 31 | 59.62% |
| No. checked for HB during the month | 88 | 41 | 46.59% |
| No. with no anaemia | 43 | 17 | 39.53% |
| No. with haemoglobin less than 11 | 44 | 23 | 52.27% |
| No. with haemoglobin less than 8 | 1 | 1 | 100.00% |
| No. with haemoglobin less than 5 | 2 | 0 | 0.00% |

## 3. VACCINATION SUMMARY

No. of vaccines given this year

| | BCG | OPV | DPT-HB | Mkinge | Measles | Vitamin A |
|---|---|---|---|---|---|---|
| At Birth | 108 | 91 | 1 | 0 | 0 | 0 |
| At One Month | 1 | 105 | 101 | 0 | 0 | 0 |
| At Two Months | 0 | 95 | 101 | 0 | 0 | 0 |
| At Three Months | 0 | 99 | 100 | 0 | 1 | 1 |
| At Nine Months | 0 | 0 | 0 | 0 | 58 | 55 |
| | 109 | 390 | 303 | 0 | 59 | 56 |

No. of vaccines given previous month

| | BCG | OPV | DPT-HB | Mkinge | Measles | Vitamin A |
|---|---|---|---|---|---|---|
| At Birth | 13 | 13 | 0 | 0 | 0 | 0 |
| At One Month | 0 | 9 | 9 | 0 | 0 | 0 |
| At Two Months | 0 | 18 | 18 | 0 | 0 | 0 |
| At Three Months | 0 | 14 | 14 | 0 | 0 | 0 |
| At Nine Months | 0 | 0 | 0 | 0 | 11 | 11 |
| | 13 | 54 | 41 | 0 | 11 | 11 |

No. of vaccines given this month

| | BCG | OPV | DPT-HB | Mkinge | Measles | Vitamin A |
|---|---|---|---|---|---|---|
| At Birth | 15 | 19 | 0 | 0 | 0 | 0 |
| At One Month | 0 | 15 | 15 | 0 | 0 | 0 |
| At Two Months | 0 | 15 | 15 | 0 | 0 | 0 |
| At Three Months | 0 | 16 | 17 | 0 | 0 | 0 |
| At Nine Months | 0 | 0 | 0 | 0 | 17 | 17 |
| | 15 | 65 | 47 | 0 | 17 | 17 |

Graph showing different vaccines given this month

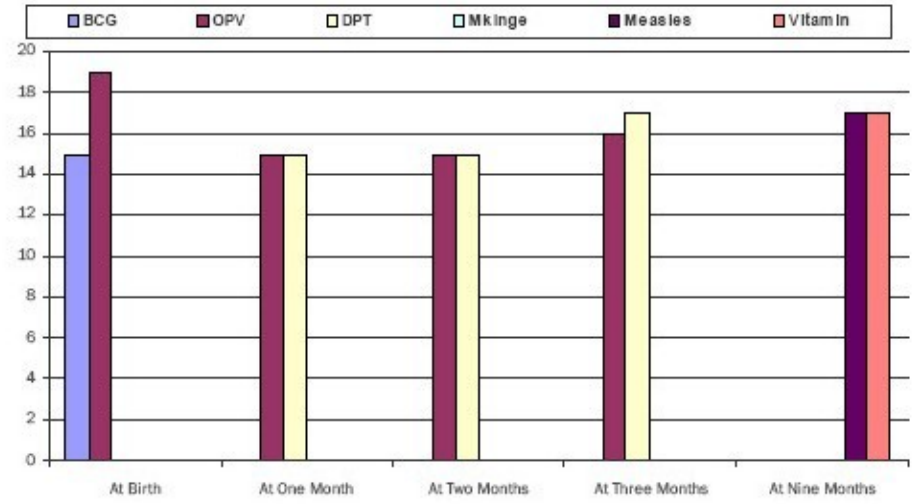

Table 1: Distribution of OPD visits, malarial diagnoses and blood slide readings April 2006-March 2007 in infants aged 2-11 months, by health centre

| | | | | | |
|---|---|---|---|---|---|
| | Number of | blood slide | | | |
| Health centre | OPD visits | readings | Number | % | |
| A | 629 | 600 | 303 | 50.5 | |
| B | 702 | 336 | 81 | 24.1 | |
| C | 395 | 378 | 180 | 47.6 | |
| D | 301 | 80 | 47 | 58.8 | |
| E | 859 | 1149 | 437 | 38.0 | |
| F | 892 | 531 | 314 | 59.1 | |
| G | 658 | 365 | 133 | 36.4 | |
| H | 548 | 643 | 250 | 38.9 | |
| I | 739 | 459 | 123 | 26.8 | |
| J | 589 | 424 | 157 | 37.0 | |
| K | 744 | 281 | 120 | 42.7 | |
| Total | 7056 | 5246 | 2145 | 40.9 | |

OPD= Outpatient Department
BS= blood slide

Table 3: Kappa scores of agreement between blood slide results from health centre laboratories and the Morbidity Monitoring laboratory

| |Health centre laboratory | |Morbidity Monitoring laboratory | |Sensitivity & Specificity | |Agreement between laboratories * | |Health centre | |n blood slides |n positive |% | |n blood slides |n positive |% | |Sensitivity |Specificity | |% agreement |Kappa score |Agreement above that expected by chance alone‡ | |A | |600 |326 |54.3 | |598 |231 |38.6 | |96.5 |72.5 | |81.8 |0.642 |Substantial | |B | |336 |220 |65.5 | |334 |99 |29.6 | |70.6 |40.0 | |51.2 |0.132 |Slight | |C | |378 |133 |35.2 | |370 |84 |22.7 | |92.8 |81.8 | |84.3 |0.626 |Substantial | |D † | |80 |- |- | |78 |11 |14.1 | |- |- | |- |- |- | |E | |1149 |566 |49.3 | |1144 |444 |38.8 | |96.8 |80.7 | |87.0 |0.739 |Substantial | |F | |531 |91 |17.1 | |487 |50 |10.3 | |96.0 |91.3 | |91.8 |0.662 |Substantial | |G | |365 |301 |82.5 | |363 |80 |22.0 | |97.5 |21.9 | |38.6 |0.098 |Slight | |H | |643 |171 |26.6 | |643 |141 |21.9 | |99.3 |93.8 | |95.0 |0.865 |Almost perfect | |I | |459 |56 |12.2 | |453 |47 |10.4 | |78.7 |95.3 | |93.6 |0.683 |Substantial | |J | |424 |126 |29.7 | |416 |99 |23.8 | |53.5 |77.6 | |71.9 |0.286 |Fair | |K | |281 |113 |40.2 | |280 |79 |28.2 | |74.7 |73.6 | |73.9 |0.429 |Moderate | |Total | |5246 |2103 |40.1 | |5166 |1365 |26.4 | |89.6 |77.3 | |80.6 |0.572 |Moderate | |

* based on n=5166

† Blood slides from health centre D were not read in the health centre

‡ Classification according to Landis and Koch (Landis and Koch, 1977)

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[1] Note more than one OPD attendance and malaria diagnosis may be included for each infant over the 12 months of this study.