EVALUATION OF HOSPITAL INFORMATION SYSTEM IN THE NORTHERN PROVINCE IN SOUTH AFRICA

" Using Outcome Measures"

Report prepared for the HEALTH SYSTEMS TRUST

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Summary

Background

In 1995 the National Department of Health (NDOH) established a National Committee to develop a National Health Information System Strategy for South Africa (NHIS/SA). The committee was made up of members from each of the nine provinces. The objective of the NHIS/SA was to provide management information for managers and health workers. The committee identified patient care and financial information systems as crucial for health care management in the country.

As a response to national strategy and in recognition of provincial need, in 1998 the Northern Province started to implement an integrated computerised Hospital Information System (HIS) in its 42 hospitals. The decision to implement HIS in this province coincided with the provincial need to restructure services, which involved shifting resources from tertiary and secondary care levels to the primary care level. Hospital Information System (HIS) was one of the restructuring strategies in the Northern province.

The two main objectives of the HIS were as follows:

- *Improve patient care by providing patient information within and between hospitals.*
- *Improve health system management in general, beyond patient care.*

Establishing an Evaluation Programme

In view of the considerable expenditure and importance of implementing HIS for provincial as well as national health care services, it was important to evaluate implementation of HIS. The aim of the study was to assess how the HIS had met its objectives and to provide lessons that can be learned from this evaluation process.

Objective of the study

- to assess the efficiency and effectiveness of HIS

Research Methodology

An evaluation framework was designed through a series of multidisciplinary workshops that included all relevant stakeholders. The framework contained qualitative and quantitative components that provided both formative and summative elements of the evaluation.

The evaluation was designed as a Randomised Control Trial (RCT). Twenty four hospitals were selected and divided into two groups of twelve hospitals each; an experimental and a control group. The 'control hospitals' were to receive the information system after the 'experimental hospitals', thereby providing a period across which to compare the two. The Investigator, the research assistant and the research co-ordinator were blinded to control bias in data collection. Both quantitative and qualitative methods were used in collecting data. Because of problems beyond the researchers' control the study changed from RCT *to a Before and After control group design. Also, the experimental group was reduced to 8 hospitals thereby increasing the control groups size to 15.* The overall aim of the qualitative component of the study was to explain the processes leading to outcome indicators such that it would compliment the quantitative component of the study. HIS successes and failures would be assessed by considering the objectives set prior to implementation. The study was conducted over sixth months of HIS implementation. Data were collected before as baseline and for sixth months after implementation.

Outcome Variables used in HIS Evaluation

The following were final variables used to evaluate HIS:

1. ***Median Time Outpatients spend at hospital.***

This is an overall indicator of the efficiency of outpatients, as well assessing some aspects of effective transfer between clinics within the hospital.

2. Length of Stay.

This is an indicator of administrative efficiency and clinical effectiveness.

3. Bed Occupancy.

This an indicator of bed utilisation, administrative efficiency and clinical effectiveness

4. Number of drug prescriptions per patient *.

This is a measure of clinical effectiveness and efficiency.

5. Improved Revenue Collection

Indicator of hospital income and of the efficiency of the hospital's financial management.

6. Cost Per Patient Per Day (CPPPD).

This is a variable which measures average patient daily costs, which enables the monitoring of units costs over time.

7. Number of Referrals

This is a measure of clinical efficiency and cost.

Data Analysis

Hospitals at which HIS was implemented were compared with those that did not have HIS after the 3rd and 6th month; primarily in terms of a change in their baseline information. In view of the variability in the data and small group sizes, the use of Wilcoxon rank sum test was decided upon at the 0.05 level of significance. The comparison amounts to testing for interaction between time and hospital group. A graphical inspection of the data rendered analysis of co-variance with baseline values as covariate superfluous . Three types of analysis were conducted for qualitative data: content analysis; inductive analysis and a process/outcomes matrix.

Findings

Findings are presented in a Matrix linkage between processes and outcomes.

The findings of the study are presented in an integrated fashion of qualitative and quantitative data. More details on the results of each component (quantitative and qualitative) of the study are found in the full text of the report and as an appendix.

The quantitative results on each outcome measure used in the evaluation of HIS are reported and explored by the qualitative results. This triangulation approach in reporting the results helps in understanding the results of the study and especially that the two methods (quantitative and qualitative) were designed in such a way that the results would be complementary.

Median Time

The quantitative findings of the study revealed that there were no changes observed in the median time spent by patients in OPD in both implemented and non implemented hospitals. In implemented hospitals the median time at baseline was 1.25 , 1.52 hours at three months and 1.39 hours at the end of the sixth month. In non implemented hospitals the median time at baseline was 1.35 hours at three months 1.25 and 1.34 hours at the end of the sixth month.

Although these findings suggest that HIS had not influenced the median time within the time period of the evaluation, the qualitative results indicated that there were positive changes in the work of OPD clerks which might resulted in a reduced median time spent by patients in OPD (qualitative report: appendix) as the HIS became more established. OPD clerks perceived HIS as changing and improving the work of registration and admission of patients. Clerks reported that the system improved their work in the areas of retrieving returning patient's records and in checking the accuracy of the information provided by the patients in the second visit. The clerks mentioned that the computer could easily trace the returning patients' records. One clerk explained "*It is even easier when the patient comes for the second or third time because the computer tells me where to find the patients' card and OPD record on the shelve".*

From such statements it became apparent that HIS had improved the work of OPD clerks . The lack of change in median time indicated that there might have been a number of other factors which could have led to the negative result in median time spent in OPD. These could include delays occurring along the care pathway in OPD, for instance if the patient had been asked to go for a chest X-RAY image and the Radiographer was not in at the time. This patient would have spent more time in X-RAY though he/she might have been clerked quicker at first contact with the OPD clerk because of HIS.

An important factor picked up from the qualitative results in relation to the lack of improvement on the median time spent in OPD *was* the number of times the electricity in the hospital went on and off as presented in the qualitative report. Another factor might be that both the computer and paper based systems were being used simultaneously. The

qualitative data reflected that the time was shortened for revisits as the system assisted in getting the patients' cards quicker. However, when there were backlogs and information was not updated because of electricity problems, patients were delayed while clerks searched and updated the system before dealing with their current visit. The qualitative findings suggested that there were extrinsic factors to the system which could be associated with the lack of change in the median time spent in OPD.

Revenue Collection

The quantitative data revealed that there was a rise in the revenue collected in those hospitals where HIS was implemented when compared with those which were not implemented (in figure I .) at assimilation phase.

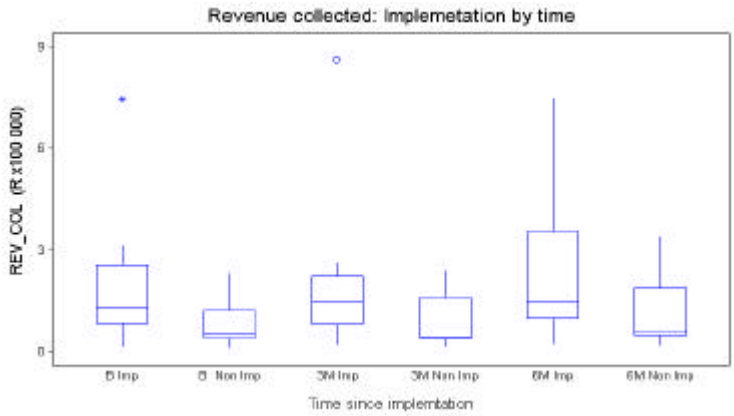


Figure I

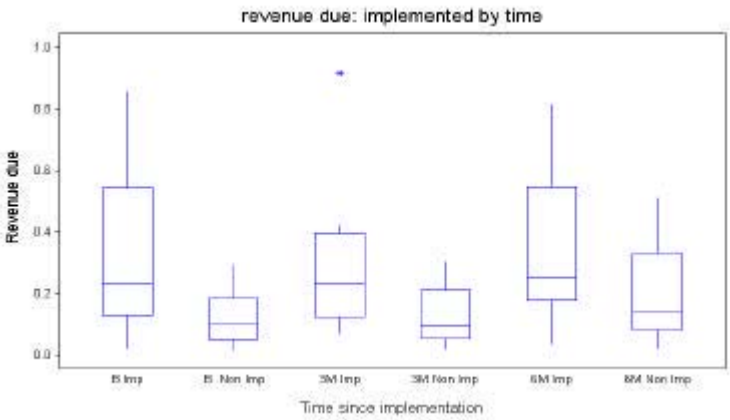
However, the difference in revenue collected at baseline showed that the implemented hospitals had higher revenue when compared with non implemented and this was suggestive of inherent differentials in financial characteristics. Revenue collection had decreased during the adaptation period (three months post implementation) when compared with the baseline revenue, while it picked up again at assimilation phase (4 - 6 months). The observed reduction in revenue was associated with the adaptation problems which appeared to have declined at assimilation stage. This indicated that the period within which the study was conducted was short, a longer time might have yielded a better insight into the behaviour of

the system and revenue collection.

As an explanation to these finding certain processes related to revenue collection mentioned in some health workers' statements and appear in the qualitative report were linked to the outcome: revenue collection. The relationship identified between processes and revenue collection was cross analysed and a matrix of linkages was developed. The qualitative findings (qualitative report: appendix I) reflected a number of activities which could influence changes in revenue collection. In this instance, poor integration of data reported by revenue clerks were likely to have resulted in low revenue collection. The revenue clerks reported that nurses were not recording all the information related to the procedures done in theatre for instance and these were the sources of revenue especially for patients who had medical aid. However, the quantitative data showed that despite these problems there was a rise in the collection of revenue in hospitals where HIS was implemented especially at six months(figure 1).

On the one hand, quantitative findings (Figure 2) showed increased revenue owed by patients in the implemented hospitals when compared with non implemented hospitals and this was not an expected outcome. In this regard the qualitative results reflected that this could be associated with the failure to discharge patients from the system (qualitative report). If the patients were not discharged from the system that increased the revenue due as the revenue clerks billed patients using information from the system, only to find later that the patient had been discharged. Again the rise in the revenue due cannot be attributed to HIS specifically but to a number of external factors to the system.

Figure 2



Bed Occupancy and average length of stay

The quantitative findings showed a reduction in bed occupancy rate in the first three months period of HIS implementation from 90.2 maximum (baseline) to 87.9 maximum at the end of the third month. The variability in bed occupancy rate was observed in quantitative data during the six months period of the study in both implemented and non implemented hospitals. This was directly linked to problems highlighted in the qualitative report such as: a backlog in updating information and a lack of computer skills amongst nurses who discharge patients. *Bed occupancy wa*s affected also when discharges were not updated as it is calculated by using the number of inpatient days. Patients who left the hospital but were not discharged accumulated more bed days. This problem in turn impacted on *the average length of stay* which did not show any changes after HIS implementation .

Cost per patient per day

There was considerable variability in the cost per patient per day in and between implemented and non implemented hospitals. This was generated by a different system since the system evaluated was not ready to do so.

Thus far the matrix linkages between process and outcome data provided an explanation on the processes that might have influenced the changes observed on outcomes measured. The process/outcome matrix was aimed at extending the description of themes, patterns, activities and explanation of the changes observed in quantitative data. It did not attempt to explain causal linkages between processes and outcomes. There is a fine line between this description and a causal relationship. According to Patton (1987) systematic qualitative enquiry does not aim to test causal relationships. Interpretations about which activities appear to lead to which outcomes; which parts of the system produce certain effects or how processes lead to outcomes are areas of evaluation speculation and hypothesizing. However, such speculations are data based and there is no reason not to share insight towards the identification of these linkages. An important point in developing the process/outcome matrix was to explain the changes or lack of them as displayed by the quantitative data. Despite all this it was difficult

to reach a conclusion of whether HIS had influenced or did not influence the outcome indicators used to evaluate it. The study indicated some of the possible explanations towards the change but not the causal relationship between HIS and changes in outcome measures. The complexity of the activities, the system and the hospital as an organisation make it difficult to conclude confidently whether HIS had an impact or not on the outcomes set to be measured.

General Conclusion

Both the qualitative and quantitative results suggested that implementing a HIS is an enormous challenge for the health service. However, there was some evidence that HIS can improve some activities. The clerks considered HIS more efficient in the registration and admission of patients in the OPD. Furthermore, an important qualitative association emerged between the system and the easy retrieval of patients' record during second and third visits to the hospitals. These findings indicated that HIS changed the work of OPD clerks positively. Like many other studies conducted (such as Heeks, *et al.* 1999 and Anderson et al. 1964) this study, evaluating HIS did not pinpoint real benefits in terms of overall impact on hospital outcome indicators. The debate about how information systems contribute to hospitals' (or other organisations') effectiveness and efficiency is ongoing. In hospital settings the nature of the organisation makes it difficult to assess the efficiency and effectiveness of the system. In hospitals a number of different factors can influence the contribution of a HIS system to the efficient running of the services that it provided. This means that the impact can only be measured by assessing a range of individual activities carried out in each section, which are then added up in a collective process to form the whole impact on the outcomes measured. Drazen*, et, al.,* (1980) explain that in organisations like hospitals the discrete impact of HIS is most predictable and measurable at the level of the individual. This view supports the results of the study, which was able to assess impact at the level of individual staff members (OPD clerks, matrons, superintendent and nurses) reported in the qualitative report later.

It is clear on the basis of both qualitative and quantitative data that there is a need to develop a fertile ground before the implementation of HIS. There is also a need for users to develop a framework of understanding about how the systems function. To implement HIS for users

who do not understand it may lead to the failure of the system. Users are drivers of the system if they do not have reasonable knowledge about it, it is difficult for it to be optimally driven to provide objectives. There is a general ignorance of information systems amongst health workers. This highlights an urgent need to educate health workers about health information systems. The major aspect that creates problems is computer incompetence amongst users. This is a major threat to the success of HIS. While technological problems can be attended to by an Information Technologist, it is not yet clear whether solutions are available for the socio/health/political problems which also influence success rate of these systems. It is crucial that more studies are undertaken in the area of health information systems in general.

Lessons Learnt

The following lessons were yielded by both methods which were used in the study (these should be divided into lessons for the "Implementing HIS" and for "Evaluating HIS"

1. It is difficult to use routine hospital performance indicators to assess HIS especially when it has not been implemented in a form that was intended.
2. Staff turn over in terms of Principal investigators should be avoided as it delays schedules.
3. Use of passive methods in data collection breeds data quality problems.
4. Use of administrative data and retrospective analysis in HIS evaluation gives inconclusive evidence.
5. Complementary data collected actively for HIS evaluation where administrative data has been used is critical in supporting evidence.
6. Innovative metric measurement for HIS evaluation must be developed.
7. Evaluation must be focused in relation with the modules available in the system.
8. Modular evaluation should be aimed for rather than the whole system at the same time.
9. Policy-makers should be persuaded to buy in to the evaluation to avoid policy changes that may lead to disruptions which could effect the study and the results.
10. More evaluation se studies are needed using a range of designs including multi-centre trials.
11. It is clear that HIS implementation needs proper planning by both the implementer

and major stake holders – the users and the department itself.

12. Implementation should have a number of teams:

(a) Quality assurance and control.

(b) Data quality control.

(c) Research.

(d) Implementation.

Background

In 1995 the National Department of Health (NDOH) established a National Committee to develop a strategy towards a National Health Information System for South Africa (NHIS/SA). The committee was made up of members from each of the nine provinces. The aim of this committee was to develop and monitor national health information system strategy which would guide the development of a national health information system countrywide. The objective of the NHIS/SA was to provide management information for health managers and health workers. The committee identified patient care and financial information systems as crucial for health care management in the country

As a response to national strategy and in recognition of provincial need, in 1998 the Northern Province started to implement an integrated computerised Hospital Information System (HIS) in its 42 hospitals. The decision to implement PCIS in this province coincided with the provincial need to restructure services, which involved shifting resources from tertiary and secondary care levels to the primary care level. Hospital Information System (HIS) was one of the restructuring strategies in the Northern province.

The two main objectives of the HIS were as follows:

Improve patient care by providing patient information within and between hospitals. The provincial accessibility of such information would improve the internal and spatial integration within and between hospitals. This integration is particularly important in the light of the referral system between hospitals and ward transfers within hospitals. Internal and spatial integration of patient information was observed by health care professionals as the best method of improving information accessibility through easy handling of medical records via the computers and network. The process of handling medical records through a computer network promises to result in the timely provision of information for diagnosis; access to lab results; easier patient administration and improved overall hospital management.

Improve health system management in general, beyond patient care. HIS is expected to improve revenue collection; aid management decision-making by identifying primary cost-drivers at hospital level and provide accessible information for management at all levels of the health system.

The evaluation process of the HIS was seen as an integral part of its implementation. During the planning stage of the HIS an evaluation team was established to plan, design and conduct an evaluation of the system. A control trial was designed to evaluate whether these objectives would be met, using a quantitative assessment. This has been complemented by a qualitative study.

A vast amount of money has been spent world wide on information technology in the health sector. In the UK alone a billion pounds has been spent on computer systems for the NHS in this first half of last decade (Audit Commission, 1995) but the evaluation of these systems has not kept pace with the investment put into developing them. In the early 1990s four UK hospitals were selected for the installation of Hospital Information and Support Systems (HISS). The literature reflects that evaluation studies of these systems were done relatively early in process of implementing them rather than after few years of operation and this has resulted in poor and inconclusive evidence of the information systems' benefits (Silcon Bridge Research, 1993; Scott and Buckingham, 1994). Lock (1996) highlights the problem and the lack of evidence to support the benefit of investing in information systems. The report on the Commission (1999) to the US government, however, indicates that information

systems need to be improved in several ways for a significant increase in investment. The difficulty to identify clear outcomes and benefits from information systems, as mentioned above, are often the result of an inability to quantify improvements or to identify them directly with the use of the computer systems.

For instance the Greenwich HISS system (which was one of the UK hospitals mentioned above in which a HISS was implemented; Silcon Bridge Research 1994) cost over £12 million in capital and revenue during development, but the only quantified savings are £86,000 per annum in Radiology and £40,000 in Pharmacy. Beyond this, there has only been one systematic review of the effect of computerisation in primary health care (Sullivan and Mitchell, 1995). From the 30 studies conducted between the 80s and early 90s only 3 measured the impact of Hospital Information Systems (HIS) on patient outcomes (Peters and Davidson, 1998). This means that there are very few studies which have been conducted to evaluate the contribution made by HIS in the health environment. Nevertheless there needs to be some attempt to evaluate the systems, probably using a combination of economic and clinical evaluative techniques.

Throughout the literature, methodology has been an area of common concern. To this end Heathfield et al (1997) have recommended that the problem of methodology can be addressed by using a framework for evaluation, especially in complex multi-disciplinary healthcare situations. Methodology is a problem, and randomised controlled trials do not seem to be appropriate (Heath filed, et, al., 1998). These tend to produce negative results, which then remain unpublished, and do not provide constructive criticisms and directions for improvements. Heathfield et al (1998) suggest that to look for evidence of cost effectiveness is actually to ask the wrong question, but not all those involved in paying for or using such systems would necessarily agree. Clinical Informatics needs to develop a multi-perspective evaluation process, integrating qualitative and quantitative methods (Ibid.).

Qualitative data are used to gain critical insight into motivations and interactions within an organisation. Detailed qualitative data that are collected from individuals about their actual processes within the organisation and its setting can be used to interpret the findings and explain how and why information systems bring about change. Tripodi (1983) suggests four

criteria which can be applied to both formative and summative evaluation. These are effort, effectiveness, efficiency and unanticipated consequences. Effort includes staff time, activity and commitment. Effectiveness refers to the extent to which the practice objectives have been achieved, while efficiency concerns the relationship of effectiveness to effort and reflects practice relative to the extent of achieved desirable change. Practice effectiveness refers to the extent to which planned objectives are achieved by users of the system or programme. Practice efficiency is the relationship of effectiveness to effort and can be easily assessed by considering changes per worker's activity (Tripodi 1983). Qualitative research methods have been used in evaluation studies of computerised systems such as laboratory information systems (Friedman and Wyatt 1994; Kaplan 1991 and Anderson, *et, al.,* 1994)

While evaluation research and scientific inquiry differ, both use the same logic of inquiry in their procedures. Scientific study focuses primarily on meeting specific standards, regardless of the organisational interest in the study. Despite the scientific rigor which is crucial in evaluation research, it must take cognisance of the interest of the organisation and stake holders. Thus, evaluation research must be conducted in such a way that it will provide information that is useful for the managers of the organisation.

Kaplan (1991) has developed models of change which are based on different conceptions of what is believed to cause change and which explain how information systems affect organisational change. These perspectives are:

- The computer system is an external force.
- The computer system design is determined by user information needs.
- Complex social interactions determine system use.

These three perspectives form a comprehensive framework within which a hospital information system can be evaluated. They also help system evaluators recognise the inadequacies of using only one perspective and encourages them to consider additional areas in the evaluation study together with research strategies involved (Anderson, *et, al.,* 1994). The evaluation of the Northern province hospital information system was approached within the framework of these perspectives in order to provide a comprehensive report for managers and other stakeholders. At the same time the Efforts/Efficiency/Effectiveness Model (EEEM)

(Tripodi 1983) was employed to guide the study design.

Evaluating information systems is notoriously difficult for many reasons, but perhaps the most important challenge is satisfying the varying expectations of the many stakeholders involved. Evaluating a multi-site HIS adds a further dimension to the complexities inherent in evaluating information systems. The literature review revealed that there are no multi-site evaluations in peer reviewed journals. It is in the interest of supporting the implementation of HIS in the Northern Province and in South Africa in general that this study was deemed necessary.

Aim of the of the study

Aims of the Evaluation Programme

In view of the considerable expenditure and importance of implementing HIS for provincial as well as national health care services, it was important to measure the success of HIS. The aim of the study was to evaluate the effectiveness of HIS to the health care services overall and to provide lessons that can be learned from this evaluation process.
The overall aim of the qualitative component of the study was to assess HIS effectiveness and to explain the processes leading to outcome indicators such that it would compliment the Before and After Control Group Design: the quantitative component of the study.
The main objective of the study was to evaluate the effectiveness and efficiency of HIS.

Objectives of HIS

1. To Improve Patient Care

- In light of the referral system that has patients moving from district to regional and central hospitals in the province, it became imperative that information belonging to patients previously treated at hospitals in the province be available at any other hospital where the patient might be admitted.
- The improvement in the health care professionals' access to patient related information

during the treatment process meant improved medical records handling and shorter turnaround time for the release of diagnostic information such as laboratory and special investigation results.

- The improvement of patient administration procedures resulting in shorter waiting times and a general better level of service to patients.

2. To improve the delivery of services across the department.

- This included the re-engineering and standardisation of patient administration and related procedures throughout hospitals in the province.
- The improvement of the information necessary for performance evaluations and health care audits.

3. To improve the efficiency of hospital management

- The HIS should facilitate decentralised financial management at hospital level.
- Improve revenue collection.
- And improve management decision-making through the availability of integrated management information.
- Envisioned was also the cost savings mechanism of identifying primary cost-drivers at hospital level and the scientific monitoring of the mechanisms introduced to lower costs.

Evaluation Research Design

Development of an Evaluation Programme

The approach and the process of developing the evaluation programme is outlined below. The process consisted of five separate, but inter-linked activities:

(i) An Orientation Study

This was the first formal study conducted as part of the evaluation process. The aim here was to obtain the views of what users thought the evaluation should address. This was done so that potential problems could be identified and preventative measures taken to improve the outcome of the project. A knowledge, attitude and perception analysis was also conducted. 250 potential users were interviewed which generated 35 questions to be addressed by the evaluation.

(ii) The Creation of an Evaluation Framework

The 35 questions were presented to a workshop supported by the Health Systems Trust (HST) containing representatives of 10 stakeholder groups and resulted in an expansion of the study to 114 questions. Through a process of collation and distillation these were incorporated into 10 separate projects to create an evaluation framework .

(iii) Designing the overall Evaluation Programme

A second workshop supported by the HST was then convened to confirm the overall design of the evaluation, prioritise the projects in the evaluation framework, provide technical advice on the drafting of the final design and to discuss the required organisational structures to support and implement the evaluation programme. It was at this stage that a randomised controlled trial (RCT) was chosen as the most robust method for undertaking the summative component of the evaluation. The RCT formed the core of the summative evaluation. The second workshop identified the priority project from the framework, where outcome assessment was considered to be most informative and also generated a number of key outcome questions. After the workshop, these were cross-referenced to create a series of 9 outcome variables that would cover as broad a perspective as possible.

(iv) Undertaking the Evaluation

The formative evaluation component of the overall evaluation was an ongoing process. Aspects of the summative evaluation (RCT) were piloted to select the final outcome variables and refine the measurement of these indicators. Only then were arrangements for the required steering, management, employment and funding structures finalised.

(v) Steering/Scientific Committee

Within this design the evaluation aimed to utilise a range of qualitative and quantitative methodologies over varying time scales each addressing specific aims of the evaluation programme. This was an attempt to provide an overview of the general impact on people and organisations of introducing high technology solutions into a relatively unprepared environment. The study design envisaged the stimulation of an evaluation culture in the health and welfare services in the Northern Province as well as building the capacity to undertake such evaluations in the future. At this stage a steering committee was established to monitor the progress of the study.

Research Methodology: Quantitative Component

The evaluation was designed as a Randomised Control Trial (RCT). According to the RCT, 24 hospitals were selected and divided into two groups of twelve hospitals each; an experimental and a control group. The 'control hospitals' were to receive the information system after the 'experimental hospitals', thereby providing a period across which to compare the two. The Investigator, the research assistant and the research coordinator were blinded to control bias in data collection. At this point it is worth mentioning the way in which the design of the study changed from RCT *to Before and After control group design. Also, the experimental group was reduced to 8 hospitals thereby increasing the control groups size to 15.*

Firstly, although the evaluation was designed as a Randomised Control Trial (RCT), circumstances dictated that the analysis be conducted as a Before and After Control study. This occurred because the order in which hospitals received the information system did not match the RCT schedules for reasons beyond the control of the evaluators. Four hospitals

from the control group were implemented while another four from the experimental group were not implemented. This crossover was the result of Year2000 (Y2K) non-compliance problems, where some of the hospitals in the control group were not Y2K compliant. According to the implementers, for logistical reasons it was necessary that these hospitals be converted to HIS first (as they would have to undergo IT changes in terms of Y2K compliance anyway). This Y2K problem developed irregularities within the RCT schedules and because of these group-crossovers it was decided that the study would be analysed as a Before and After Control Group design.

Secondly, for other policy related reasons HIS installation had to be stopped in the course of implementation and consequently four of the experimental hospitals were not computerised. This mismatch resulted in a sample of 8 experimental and 15 control hospitals for the study (one of the hospitals was closed and that reduced the total sample size to 23 instead of the original 24 hospitals).

This kind of unplanned and unanticipated *unequal randomisation* is not common in clinical trials. While it is common to increase the sample size of the treatment group and decrease the size of the control group (Pocock, 1984), this reverse form of *unequal randomisation* threatened to impair the statistical efficiency of the HIS evaluation. However, the major strength of this study is the use of computer systems in meeting health care objectives and this was measured unobtrusively via hospital outcome indicators. Any changes whether positive or negative in the outcome variables used to measure the impact of HIS would not have been manipulated for this study. The value of the study, therefore, persists despite these methodological problems and, in fact, has been able to clarify some of the issues pertaining to HIS implementation.

Friedman and Wyatt suggest (1996) that the problems which arise when attempting to run an evaluation study are often the expression of stake-holders who do not value the information which may be obtained from the study. Some stake-holders do not value the information which may be obtained from the study and therefore become reluctant to prolong the current version of the system long enough for the study to be completed.

Sampling Method

Stratification

The hospitals were stratified and divided into three groups based only on the number of beds in each hospital.

Sample Size Calculation

This was difficult as there were a range of outcome variables with little prior knowledge. An additional parameter, to be determined, was the number of cases that needed to be studied per cluster in order to obtain the required precision in the estimated value of the measure. An initial sample size calculation using the "Cluster" sample size calculator gave an estimate of 75 patient records that need to be studied per hospital for the median time.

Choosing Outcome Variables as Measures

The criteria for deciding on the variables to use were:

(i) Those likely to be affected by the HIS

(ii) Those which could feasibly be measured without the HIS in place (for baseline measures in all hospitals and follow up measurements in late implementation sites).

(iii) Those which would reflect a key hospital or health care process.

(iv) Criteria associated with improved or worsened patient experience (total time in the hospital) or outcome (e.g. unintended re-admission rate).

(v) Those associated with availability of improved administrative, managerial or policy information.

(vi) Criteria which could be measured repeatedly without exerting a strong Hawthorne effect.

(vii) Those criteria which could be measured repeatedly using routine data to allow changes over time to be studied.

The chosen variables were piloted in 3 hospitals to assess their feasibility of collection. This was a process of refinement of the outcome variables measured.

Outcome Variables used in HIS Evaluation

1.Median Time Outpatients spend at hospital

This is an overall indicator of the efficiency of outpatients, as well assessing some aspects of effective transfer between clinics within the hospital.

2. Length of Stay

This is an indicator of administrative efficiency and clinical effectiveness.

3. Bed Occupancy

This an indicator of bed utilisation, administrative efficiency and clinical effectiveness

4 . Number of drug prescriptions per patient *

This is a measure of clinical effectiveness and efficiency .

5. Improved Revenue Collection

Indicator of hospital income and of the efficiency of the hospital's financial management.

6. Cost Per Patient Per Day (CPPD)

This is a variable which measures average patient daily costs, which enables the monitoring of units costs over time.

7. Number of Referrals

This is a measure of clinical efficiency and cost.

NB: Indicators, with asterisks were not connected to the computer system and were paper based.

General Method of Data collection for the study

Data were collected from 24 hospitals for baseline while data for post implementation were collected from 23 hospitals. As explained before the 24th hospital dropped out because it was closed after the collection of the baseline data. Three months had to elapse before the first set of post implementation data could be collected from both hospitals which had, and had not (control group), implemented HIS. This time was regarded as the *adaptation period* of HIS. In the first week of the fourth month data for all outcome variables were collected in both the implemented and non implemented hospitals for the prior three months. The second set of

data from these hospitals were collected after six months of implementation (*assimilation period*) from both experimental and control hospitals. HIS was not evenly rolled out to the 23 hospitals, however, which led to an interrupted time series in the data collection. Baseline data for all outcome variables were collected from April to the end of June 2000 for the past three months, while post implementation data were collected from July 2000 to June 2001. The research assistant visited all the 24 hospitals to collect data. The information collected from each hospital was entered onto a Data Capture Sheet designed during planning, it was then collated and entered into a Microsoft excel spread sheet. These data were collected at the end of each month for a period of three months for both experimental and control hospitals. Further collection was done after three months for the fourth, fifth and sixth months of HIS implementation (assimilation period).

Median Time

The data on the number of outpatients usually seen in each hospital forms a basis on which to decide how many records and from which median time data would be collected. Data were collected from the 75 patient records for both baseline and post implementation median time. Brightly coloured cards with spaces to register the time on entry and exit of patients were disseminated to the matrons in each of the 24 hospitals selected for the study. The assistant researcher delivered the cards to the matrons a week before the date for data collection and explained to the matrons, clerks and pharmacy staff how this information should be registered on the cards. Thursday was conveniently chosen as a day for all hospitals to collect data for median time in OPD for baseline data and this was a way of standardising data collection. The matrons were reminded by the telephone to give OPD clerks these cards the day before the data were collected. Clerks were instructed to register time on the coloured card and attach it to the patients' record for the first 75 patient encounters in OPD on Thursday. The time recorded by the clerk was regarded as the entry time. Patients were requested to remind the staff at the pharmacy about this coloured card. The pharmacy was defined as an exit point for this study and staff at the pharmacy in each hospital were asked to record the exit time on the coloured card and keep the card, after they had dispensed medication to the patients. The research assistant visited all the 24 hospitals to collect these cards from the pharmacy. Data for median times was entered into a computer

spreadsheet. Microsoft Excel was used to sort data into an ascending order and the common 'middle time' was picked as the Median time. This method was maintained for post implementation data collection of median time.

Bed Occupancy

Data for Bed Occupancy were collected from the performance indicator list in the clerks' office in each hospital. The performance indicator list contains the total number of inpatients and the number of available beds. The formula used to calculate bed occupancy was***:***

Total number of inpatients for 3months x 100 *(Divide the total inpatient by available beds times 100)*
Available beds = Bed Occupancy

The data on inpatient and available beds for each hospital were captured on a spreadsheet so that the Bed Occupancy could be calculated using the above formula. This method was used for both pre and post implementation data collection for Bed Occupancy.

Revenue Collection

Data for revenue were collected from the revenue office registers. The monthly financial summary contains information on: revenue collected; revenue due and revenue outstanding. This information was entered into the computer.

Cost per patient per Day

The data on Cost per patient per day (CPPD) were collected from the provincial department, while the information on expenditure from hospitals was retrieved from the financial system.

This information or 'total expenditure' was captured according to the formula:

Total expenditure for 3months ***(total expenditure divide by inpatient plus a third of OPD Visits)***
Total number of inpatient + 1/3 of the OPD visits

Average Length of Stay

Data for the average length of stay were collected from the monthly statistical summary from the administrative offices in each hospital. The following statistical information was found in the monthly statistical summary: total number of inpatient days; the total number of discharges and the number of deaths. The formula for calculating Average Length of stay was:

Total inpatient days (*total inpatient days divide by discharges plus deaths*)
Discharges + Deaths

Number of referrals to other hospitals

Data on referrals were collected from the monthly statistics in each office. A figure on referrals used was necessary to calculate referral rates. The formula for referral rates was:

Percentage (*total numbers of referrals divide by admissions times 100*)
Total number of admission = Referral Rates

Prescription per Patient

Prescription data were collected from the monthly statistical records at the hospital pharmacy. The information in the records included the total number of inpatient and outpatient prescriptions as well as total number of drug items for both in and outpatients. The formula used to calculate prescriptions per patient was:
Number of items per prescription (*total number of drug items divided by total number of prescription*)
Prescription = Prescription per patient

Data Analysis

Hospitals at which HIS was implemented were compared with those that did not have HIS after the 3rd and 6th month; primarily in terms of a change in their baseline information. This was done by using the non-parametric Wilcoxon rank sum tests at the 0.05 level of

significance. The comparison amounts to testing for interaction between time and hospital group. A graphical inspection of the data rendered and the analysis of co-variance with baseline values as covariate superfluous. In view of the variability in the data and small group sizes, the use of Wilcoxon rank sum test was decided upon.

Findings of the Quantitative component of the study

The results in Table 1 for implemented hospitals showed that the median bed occupancy rate decreased steeply by the end of the third month from 87.9% at baseline to 66.1% with a remarkable difference of 21%. A rise to 71.6% was observed at the end of the sixth month period of HIS implementation. The decrease of bed occupancy at the three month juncture was significant (p=0.02) for implemented hospitals and at the end of the sixth months the difference from baseline was also statistically significant (p=0.05). Caution should be taken in interpreting the changes in median bed occupancy, because this outcome is influenced by a number of factors; including: population morbidity, level of skills, condition of patients, diagnosis, treatment etc. In the case of non implemented hospitals the median bed occupancy remained virtually unchanged with a slight rise at the end of the third month. A high variability in this measure was shown by the wide gap between the minimum and the maximum rates for both non-implemented and implemented hospitals and also over the period within which the study was conducted. Despite this variability, the decrease in the implemented hospitals was statistically significant.

Table 1 : Distribution of Bed Occupancy rate for baseline, 3 & 6 months

Time	implemented hospitals		non-implemented hospitals
Baseline			
Minimum	***43.9***		***18.1***
Median	***87.9***		***63.1***
Maximum	***90.2***		***11.1***
Three months			
Minimum	*32.1*		*16.7*
Median	*66.1*	*(p=0.02)*	
Maximum	*87.9*		*89.2*
Six months			
Minimum	*34.9*		*22.2*
Median	*71.6*	*(p=0.05)*	*65.4*
Maximum	*101.7*		*90.9*

The average length of stay ranged from 2.8 to 10.2 days across all the hospitals during the study. It could be seen that there had been no change in the median of the average length of stay of both non HIS implemented and HIS implemented hospitals (in Table 2). The comparison of the median of the average length of stay between hospitals that implemented and those that did not implement HIS, showed that the length of stay in non-implemented hospitals had been slightly higher than in implemented hospitals.

Again the system went on off line might had been responsible for the lack of change in average length of stay as shown by the qualitative results. Superintendents reported that the system went off line several weeks and that caused backlogs in information updates. This finding indicates that the problem of not updating information could be associated with lack of change in the average length of stay in hospitals where HIS was implemented.

Table 2. Average length of stay at baseline, three & six months

Time	Implemented	Non- Implemented
Baseline		
Minimum	*3.2*	*2.8*
Median	*4.8*	*5.0*
Maximum	*7.1*	*10.3*
Three months		
Minimum	*3.1*	*3.4*
Median	*4.0*	*5.8*
Maximum	*9.8*	*10.2*
Six months		
Minimum	*3.1*	*3.2*
Median	*4.5*	*6.1*
Maximum	*8.4*	*8.3*

There was a rise in revenue collected (Figure 1) at the end of the sixth months in HIS implemented hospitals while the same could not be stated about non HIS implemented hospitals.

Figure 1.

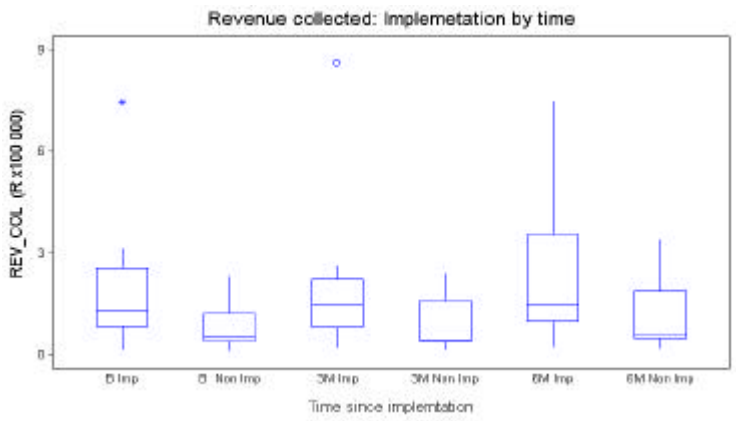
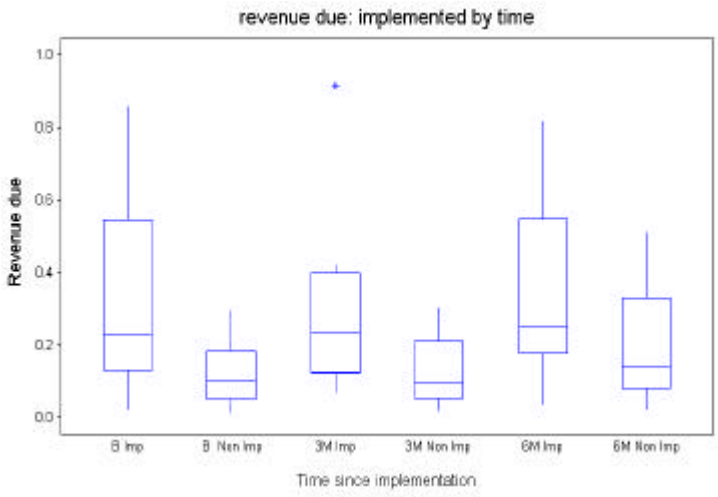


Figure 2.



Despite the rise in revenue collection at HIS implemented hospitals at six months an observation on revenue due was high when compared with the revenue due for non implemented hospitals (Figure: 2). The non HIS implemented hospitals appeared to have lower amounts of revenue owing than their counterparts. The inconsistent pattern in revenue due and collected was associated with the different financial characteristics of hospitals. This was more evident when baseline data on revenue collection were compared between hospitals. Qualitative research results reflect that revenue clerks found it time consuming and problematic that the system went off-line at times, particularly in terms of having to update the information at a later stage. A recurring problem was that a patient who had left the hospital was not discharged on the system. Revenue officers would find that patients were in the ward according to the system yet on further manual follow up would find that they were no longer in hospital. This created problems in terms of billing, as the length of a patient's stay was used to bill Medical Aid patients. If a patient was not discharged from the system, over billing could occur. One revenue clerk said, "*It is embarrassing when somebody rejects the claim you appear as if you are a fool, nurses need to discharge patients immediately from the system*". Also the incorrect billing of patients who might have left the hospital could have

been the result of high rate of revenue due in hospitals where HIS had been implemented. It would appear that the revenue clerk might have billed patients who had left the hospitals because the system was not updated.

Table 3: Median time outpatient spent in hospital at baseline, three & six months

Time	Implemented	Non- Implemented
Baseline		
Minimum	*0.10*	*0.45*
Median	*1.25*	*1.31*
Maximum	*2.17*	*2.48*
Three months		
Minimum	*1.29*	*1.07*
Median	*1.52*	*1.25*
Maximum	*2.35*	*2.26*
Six months		
Minimum	*1.19*	*1.25*
Median	*1.39*	*1.34*
Maximum	*2.16*	*1.53*

As far as the median time spent by patients in OPD (Tables 3) there was generally no change in the median, except for a longer median time observed at the end of the third month of HIS intervention. Although the quantitative results showed negative changes in the median time spent in OPD, the qualitative results revealed that Clerks perceived HIS as changing and improving the work of the registration and admission of patients by clerks in OPD. Clerks in all hospitals visited responded positively about the system, and proved to be the group whose functions were most significantly improved by the system. The registration clerks in OPD reported that the system improved their work in the areas of: retrieving returning patients' records and checking the accuracy of the information provided by the patient in the second visit. This suggested that the negative results on median time spent in OPD might had been influenced by extrinsic factors to the system and this issue is discussed later (in the qualitative report see appendix).

Cost per patient per day showed an increase in the median at the end of the sixth month. However, this information was provided by another system not the one which was evaluated.

Table 4:Cost per patient per day at baseline, three & six months (in Rand)

Time	Implemented	Non- Implemented
Baseline		
Minimum	*189.60*	*195.40*
Median	*366.01*	*468.80*
Maximum	*634.90*	*895.40*
Three months		
Minimum	*202.70*	*244.00*
Median	*398.40*	*396.70*
Maximum	*686.70*	*737.60*
Six months		
Minimum	*206.10*	*294.70*
Median	*386.15*	*432.40*
Maximum	*750.10*	*704.40*

The data on items per prescription per patient were not been subjected to further analysis because they were paper based and could not have been influenced by HIS implementation. Also referral data were not analysed because they were incomplete . (see appendix Tables) .

Limitations of the Quantitative Component of the study

This study like many studies had its own limitations. The small sample size of HIS implemented hospitals limited the statistical tests which should have been conducted in a bigger sample, as discussed in the data analysis section. These were as a result of methodological and policy issues as highlighted earlier. Methodologically RCT had been fundamental in reducing issues of bias and to a certain extent, on reflecting a causal relationship. However, problems which had introduced biases (leading to Before and After Design) had weakened the scientific rigour of the study. Nevertheless, the relevance and importance of the study for new knowledge and better understanding of using outcome research in evaluation of HIS is a major gain in the information age era. Methodological limitations covered the following areas*: (i) use of higher level outcome as a measure of effectiveness or the impact of HIS in a hospital setting (ii) use of administrative data and*

retrospective analysis (iii) use of available outcomes with low sensitivity.

Matrix of linkages between process statements and outcome measures

The linkage between process and outcome was a fundamental issue for the qualitative component of this study, which was aimed at explaining the processes which might have led to changes in the outcome variables that were set earlier in the overall study: *median time spent by patients in OPD; average length of stay; bed occupancy; number of patients admitted; number of patients discharged; improved revenue collection; cost per patient per day.*

Median Time

The findings of the study revealed that there were no changes observed in the median time spent by patients in OPD in both implemented and non implemented hospitals. The same results were observed between baseline and post intervention data . Although These results reflected that HIS had not influenced the median time spent by patients in OPD. These findings were not conclusive especially if one considered the statements made by OPD clerks in implemented hospitals which appear in the qualitative report later, (appendix I). OPD clerks perceived HIS as changing and improving the work of registration and admission of patients. Clerks reported that the system improved their work in the areas of: retrieving returning patient's records and in checking the accuracy of the information provided by the patients in the second visit. The clerks mentioned that the computer could easily trace the returning patients' records. One clerk explained "*It is even easier when the patient comes from the second or third time because the computer tells me where to find the patients card and OPD record on the shelve".*

From such statements it became apparent that HIS had improved the work of OPD clerks and this was a fact that otherwise would have led to a reduction in the median time spent by patients in OPD. The lack of change in median time indicated that there might have been a number of spurious factors which could have led to the negative result in median time spent in OPD. Some of these factors might have been delays occurring along the care pathway in

OPD. For instance if the patient had been asked to go for a chest X-RAY image and the Radiographer was not in at the time, that patient would have spent more time in X-RAY though he/she might have been clerked quicker at first contact with the OPD clerk because of HIS.

An important factor picked up from the qualitative results in relation to this negative change on the median time spent in OPD *were* the number of times the electricity went on and off as reported in the qualitative report. Another influential factor which might have lengthened the median time was the use of both the computer and paper based systems simultaneously. The qualitative data reflected that the time was shortened for revisits as the system assisted in getting the patients' cards quicker. However, when there were backlogs and information was not updated because of electricity problems patients were delayed while clerks searched and updated the system before dealing with their current visit. The qualitative findings presented in an attempt to explain the poor reduction in the median time spent in OPD suggested that there were extrinsic factors to the system which could be associated with the lack of change in the median time spent in OPD as observed in quantitative data and mentioned earlier. Therefore, it became difficult to conclude on the basis of the results on negative changes in the median time that the system itself did not influence the median time spent in OPD .

Revenue Collection

Certain processes related to revenue collection that were mentioned in some health workers' statements and appear in the qualitative report have been linked to the outcome: revenue collection. The relationship identified between processes and outcomes was cross analysed and a matrix of linkages was developed, which is presented in the table below. As demonstrated in the table as well as workers' reports (particularly those of revenue clerks) there were a number of activities which could influence changes in revenue collection, as seen in cell 7 of the table. In this instance, poor integration of data reported by revenue clerks were likely to result in low revenue collection. The revenue clerks reported that nurses were not recording all the information related to the procedures done in theatre for instance and these were the sources of revenue especially for patients who had medical aid. However, the quantitative data showed that despite these problems there was an increase in the collection of

revenue in hospitals where HIS was implemented. On the one hand, the results on increased revenue due in the implemented hospitals reported earlier might be associated with the failure to discharge patients from the system (qualitative report).

Bed Occupancy and average length of stay

The variability in bed occupancy rate observed in quantitative data was directly linked to problems highlighted previously and later in the qualitative report: such as a backlog in updating information and a lack of computer skills amongst nurses who discharge patients. *Bed occupancy (cell1) wa*s affected also when discharges were not updated as it is calculated by using the number of inpatient days. Patients who left the hospital but were not discharged accumulated more bed days. This problem in turn impacted on *the average length of stay (cell 6)* as it is calculated also using inpatient and discharge figures.

Cost per patient per day

Cost per patient per day (cell 3) could not be fully provided by the system since some of the modules necessary to calculate this were not developed at the time of the study. Thus far the matrix linkages provided an explanation of the processes that might have influenced the changes observed on outcomes measured. The process/outcome matrix was aimed at extending the description of themes, patterns, activities and explanation of the changes observed in quantitative data. It did not attempt to explain causal linkages between processes and outcomes. There is a fine line between this description and a causal relationship. According to Patton (1987) systematic qualitative enquiry does not aim to test causal relationships. Interpretations about which activities appear to lead to which outcomes; which parts of the system produce certain effects or how processes lead to outcomes are areas of evaluation speculation and hypothesizing. However, such speculations are data based and there was no reason not to share insight towards the identification of these linkages. An important point in developing the process/outcome matrix was to explain the changes or lack of them as displayed by the quantitative data. Despite all this it was difficult to reach a conclusion of whether HIS had influenced and not influenced the outcome indicators used to evaluate it. The study indicated some of the possible explanations towards the change but

not the causal relationship between HIS and changes in outcome measures. The complexity of the activities, the system and the hospital as an organisation make it difficult to conclude confidently whether HIS had an impact on the outcomes set to be measured.

MATRIX OF LINKAGES BETWEEN PROCESSES AND OUTCOMES

Processes leading to Outcome Indicators

Processes	***Outcomes***
1 > poor information on inpatients System failure & discharge of patients Poor information update	Average Bed Occupancy rate: positive but inconclusive
3 > poor integration of Information from different systems used for other services: system incomplete : information not adequate	Cost per patient per day calculated but inconclusive
4 > poor update on discharge information System failure Poor electricity supply Poor computer skills Backlogs and poor information update	Discharges influenced by processes: could results in poor quality of data
5 > quick reaction on system contact > running of systems concurrently > retrieval of revisit updating patients' information delays in the carepathways	Median time spent in OPD could be influenced by extrinsic processes: inconclusive
6 > poor discharge information > poor death information inpatient information : system failure : backlogs	Average length of stay no change
7 > integration of OPD revenue data tracing of patients poor integration of ward data	Revenue collection Revenue due

General Conclusion

Despite all the problems identified (including those associated with information integration), superintendents reported that they were able to achieve, with great effort at times, the outcome indicators. As well as this, revenue clerks were able to integrate information from the OPD for revenue collection. Another qualitative significance that could not be ignored was the issue of improved socio-demographic information from the OPD records. Nurses explained that this information improved by 60-70%, which suggested evidence of qualitative association between the system and socio-demographic data on patients' record. Like many other studies conducted (such as Heeks, *et al.* 1999 and Anderson et al. 1964) this study, evaluating HIS did not pinpoint real benefits in terms of overall impact on hospitals. The debate about how information systems contribute to hospitals' (or other organisations') effectiveness and efficiency is ongoing. In hospital settings the nature of the organisation makes it more difficult. In hospitals a number of different sections function separately but interdependently. This means that the impact can only be measured by considering a number of successful individual activities carried out in each section, which are then added up in a collective process to form the whole impact on the outcomes measured. Drazen*, et, al.,* (1980) explain that in organisations like hospitals the discrete impact of HIS is most predictable and measurable at the level of the individual. This view supports the results of the study, which was able to assess impact at the level of individual staff members (matrons, superintendent and nurses) reported in the qualitative report later.

It is clear on the basis of the data that there is a need to develop a fertile ground before the implementation of HIS. There is also a need for users to develop a framework of understanding about how the systems function. To implement HIS for users who do not understand it may lead to the failure of the system. Users are drivers of the system if they do not have reasonable knowledge about it, it is difficult for it to be optimally driven to provide objectives. There is a general ignorance of information systems amongst health workers. This highlights an urgent need to educate health workers about health information systems. The

major aspect that creates problems is computer incompetence amongst users. This is a major threat to the success of HIS. While technological problems can be attended to by an Information Technologist, it is not yet clear whether solutions are available for the socio/health/political problems which also influence success rate of these systems. It is crucial that more studies are undertaken in the area of health information systems in general.

The study suggests that some outcome variables are not suitable for HIS evaluation especially if the system is not complete. This suggests that the evaluation should be focused on modules which are implemented, or in areas where benefits can be more tangibly realised. Another important point is that it was too early to conduct summative evaluation, as summative evaluation should be conducted at least a year or two after implementation to get more useful results. Also emphasis should be placed on formative evaluation in order to inform implementation.

ABSTRACT

Both the qualitative and quantitative results suggested that implementing a HIS is an enormous challenge for the health service. However, there was some evidence that HIS can improve some activities. The clerks considered HIS more efficient in the registration and admission of patients in the OPD. Furthermore, an important qualitative association emerged between the system and the easy retrieval of patients' record during second and third visits to the hospitals. These findings indicated that HIS changed the work of OPD clerks positively. The study suggested that some outcome variables are not suitable for HIS evaluation especially if the system is not complete. This indicates that the evaluation should be focused on modules which are implemented, or in areas where benefits can be more tangibly realised. Another important point is that it was too early to conduct summative evaluation, as summative evaluation should be conducted at least a year or two after implementation to get more useful results. Also emphasis should be placed on formative evaluation in order to inform implementation.

It is clear on the basis of the data that there is a need to develop a fertile ground before the implementation of HIS. There is also a need for users to develop a framework of

understanding about how the systems function. To implement HIS for users who do not understand it may lead to the failure of the system. Users are drivers of the system if they do not have reasonable knowledge about it, it is difficult for it to be optimally driven to provide objectives. While technological problems can be attended to by an Information Technologist, it is not yet clear whether solutions are available for the socio/health/political problems which also influence success rate of these systems. It is crucial that more studies are undertaken in the area of health information systems in general.

Lessons Learnt

13. Use of hospital performance indicators for a non complete information system is problematic.
14. Staff turn over in terms of Principal investigators should be avoided as it delays schedules.
15. Use of passive methods in data collection breeds data quality problems.
16. Use of administrative data and retrospective analysis in HIS evaluation gives inconclusive evidence.
17. Complementary data collected actively for HIS evaluation where administrative data has been used is critical in supporting evidence.
18. Innovative metric measurement for HIS evaluation must be developed.
19. Evaluation must be focused in relation with the modules available in the system.
20. Modular evaluation should be aimed for rather than the whole system at the same time.
21. Policy-makers should be persuaded to buy in to the evaluation to avoid policy changes that may lead to disruptions which could effect the study and the results.
22. Another evaluation study is needed and more studies on multi-centre trials are needed.

11 . It is clear that HIS implementation needs proper planning by both the implementer and major stake holders – the users and the department itself.

12. Implementation should have a number of teams:

(a) Quality assurance and control.

(b) Data quality control.

(c) Research.

(d) Implementation.

(a) Co-ordination.

These teams should work as collaborators and meet after every stage of implementation.

14. The implementation team should be representative of all stake holders.

15. Tender specification must be written and reviewed by users and other stake holders and should be continuously available as a reference. Continuous training should occur in groups as well as on the job. Separate computers should be available for training in each hospital.

16. Realities and unexpected consequences should be explained to users to avoid unreasonably high expectations.

17. Technical support systems should be accessible at all times.

18. Development of subsequent modules should not take too long after the first module has been implemented.

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Appendix 1

QUALITATIVE REPORT

Objectives of the study for the qualitative Component

Assessment of HIS in improving revenue collection: collect qualitative data on the revenue collection process, fees and Medical Aid.

Assessment of HIS in providing outcome indicators and information integration: gather qualitative data on HIS information provision in the areas of referral systems; hospital outcome indicators (bed occupancy and average length of stay); patient admissions and patient discharges.

Assessment of HIS in providing financial information for planning: collect qualitative data on computer processes that deal with budget expenditure and costs.

Evaluation of HIS in patient administration and referral: gather qualitative data on referral, patient administration and admission.

Research Design for the qualitative Component

As explained in the report earlier, the evaluation was designed as a Randomised Control Trial (RCT). Circumstances dictated that the analysis be conducted as a Before and After Control study. However, this does not in any way affect the qualitative evaluation.

According to the RCT design 24 district hospitals were selected and divided into an experimental group and a control group. Each group consisted of a dozen hospitals. The implementation of the information system took place in the experimental hospitals before the control hospitals, thereby providing a period of comparison. Qualitative research was conducted in a subset of 7 hospitals chosen from the original 24: four hospitals with new HIS and three without. This type of research was used for evaluation because it provides an understanding of the system from the viewpoints of the users as well as the processes leading

to outcome indicators. It also helps to determine the influence of the social organisational context on system use, which is significant because computer systems do not and cannot exist in a vacuum. The implementation and use of a computer system occurs in a social and organisational context that shapes what happens at the contact stage.

Although experimental interventions can illustrate the existence of the causal relationship they are not competent in revealing how causal processes work (Cook 1985). Qualitative methods provide an opportunity to examine the actual processes involved and to form explanations for the events and processes that lead to specific outcomes.

The evaluation programme asked five questions:

1. Does HIS improve the quality of decisions by making information readily available to health workers and health managers?
2. Is the information being utilised to improve the efficiency and effectiveness of services ?
3. Can HIS improve the efficiency of revenue collection?
4. To what extent can HIS reduce waiting time in OPD?
5. Does HIS provide hospital outcome indicators with ease?

These questions, focussed on the effectiveness and efficiency of HIS, formed the basis upon which an evaluation for HIS was developed and designed.

Data collection For the Qualitative Method

The 7 hospitals selected for the qualitative component of the study were chosen according to size, which was important in order to investigate how HIS is evaluated in big and small hospitals respectively. Of the 7, HIS was implemented in four experimental hospitals while the remaining three (control hospitals) were not computerised. The Effort/Effectiveness/ Efficiency Model (Tripodi 1983) was used to guide the qualitative methods used to collect data from these hospitals. The link between the objectives of HIS and the EEEM are shown in appendix An interview schedule (see appendix) was designed within this model and used to interview key informants and guide focus group discussions. Thirty key informants were systematically interviewed: superintendents, matrons, revenue clerks and OPD clerks. Six

focus group discussions were conducted with ward nurses in each of the hospitals visited. Focus group discussion could not be held in one hospitals without HIS because of time constraints amongst nurses. The questions, which were asked in both in-depth interviews and focus group discussions, related to time efforts in performing daily functions and effectiveness of the system in providing information needs. Data was collected using tape recorders and by taking notes.

Most participants in the study signed consent forms. In some cases the consent was verbal because the study was well-known as it was advocated by the provincial office prior to implementation. Participants in hospitals expressed willingness to take part.

Data Analysis

Three types of analysis were conducted: content analysis; inductive analysis and a process/outcomes matrix.

Content Analysis

Information maps were developed manually from the notes to identify clear themes and topics. The content analysis method was conducted. The data were also recorded into a computer programme, which generated transcripts that were then systematically searched for words, phrases and concepts, which were developed into themes. Recurring themes were identified. Categories of identified themes were then grouped according to similarities and differences between the data collected from focus group discussions and data collected from key informants or individuals in hospitals. The themes were cross analysed to check the difference between those in early and those in late in terms of efforts, effectiveness and efficiency of HIS. An Effort/Effectiveness/Efficiency Model was used to analyse data (see appendix).

Inductive Analysis

Themes and categories of analysis that emerged from the data were further analysed. The

natural variation of the data was observed and particular attention was paid to the different ways in which participants responded and claimed to be affected by the system. This included patterns and categories which were not effectively articulated. Terms were inductively developed further to describe these patterns and categories so as to generate meaning and draw implications from the data.

A Process/Outcomes Matrix

The main aim of this component of the study was to explain the changes in the outcome indicators of the quantitative component of the study, therefore linking processes which appeared to have potential influence on outcome indicators was important. This type of analysis laid a crucial foundation for the later explanation of which processes led to which outcome indicators. In this type of analysis data is organised in such a way that processes and outcome are linked. Participant's process statements or reports that were considered to be directly influential on the outcome were connected to those outcomes by a matrix of linkages between processes and outcomes. Process statements and outcome indicators were tabulated according to their relationship and this cross classification produced cells in the matrix.

Findings of Qualitative Component of the study

The findings are presented into two sections: a descriptive report and an explanatory report. The descriptive report presents, with minimal interpretation, indirect statements and quotations as expressed by participants of the study while the qualitative explanatory report includes interpretation and conclusions as reached by inductive analysis.

Part One: Descriptive Report

Background Characteristics of District Hospitals, Key Informants and Focus Groups

Qualitative data were collected in seven district hospitals; four which had the HIS implemented and three which did not. The size of the experimental hospitals ranged from 56 to 272 beds, while the control hospitals ranged in size from 40 to 320. The hospitals were chosen on the basis of how long the system had been in place. Two of the experimental hospitals had already completed both the *adaptation* (first three months of implementation) and *assimilation* (first six months after implementation) periods. The other two experimental hospitals were in their fourth month of implementation having just finished the a*daptation* period. The size of the hospital and the period of implementation were important factors in terms of evaluating and understanding the impact of the HIS. The influence of these factors is discussed later in this report.

Key Informants and Focus Groups

The Key Informants from the hospitals were: the superintendent, the matron, the revenue officer, nurses in maternity wards and general wards, clerks in OPD, doctors and administrative clerks at the registration office. Focus group discussions were held with nurses from the general wards and maternity wards in visited hospitals. Nurses who participated in group discussions were both young and old.

The Impact of HIS on the Overall Management of Hospitals by Superintendents

Information Needs

Superintendents identified both internal and external information needs. Internal information was needed regarding the number of patient admissions, discharges and transfers in and out; diagnoses and medical categorisation (medical, surgical etc) of patients admitted; numbers and types of medical prescriptions made and information regarding personnel, finances (budget, expenditure, revenue), equipment, transport and maintenance. This information was

necessary for the transaction of day to day functions, internal decision making and general management.

In terms of external information, the most important areas that the superintendents identified as requiring attention were transfers in from other hospitals and changes to regulations by district and other offices. As well as this, other information was deemed necessary for strategic planning. The complex nature of the superintendents' information needs are presented below in the form of a cobweb diagram on the next page.

Efforts in Retrieving Information from the System

The respondents observed that the system made it easier to trace patients' records, especially in light of the fact that records were filed using Microsoft Access. This data base file format made records accessible in a few minutes and proved to be an excellent time-saving tool. In some hospitals, superintendents noted that the time taken to admit patients increased from about 5 to 7 minutes. This was attributed to staff's poor computer skills. Superintendents in the four hospitals visited, further reported that electronic reminders reduced the use of paper reminder cards as well as reducing the time between sending and receiving the reminders. One superintendent reported that the process of retrieving financial information from the revenue office was made more efficient and direct by eliminating the roles of the secretary and the revenue clerk and sending it through electronically instead of via manual paperwork. Two of the superintendents mentioned that auditing became simpler and easier as they were able to simultaneously access expenditure and budget records unobtrusively. Since the data were readily accessible, the system allowed superintendents to better manage their time by working when other staff were not available.

Superintendents mentioned that they considered the case mix method for outcome variables time consuming. At times, the system became so slow that it would take 5 - 20 minutes to get some of the outcome indicators. This non-integration made the system less user-friendly. Superintendents were at times forced by the non-integration of the system to manually find files in order to calculate indicators, such as the bed occupancy rate, which requires both bed

Superintendents'Information Needs

Information needs for Superintendents in Hospitals to plan everyday transactions for Annual Reports etc.
Admin Reports
Medicine Analysis
Transfer
Seasonal Trends
Dis Report
Admission & Discharge
Kitchen
Pharmaceutical
Lab
Diagnosis
X-Ray Reports
Budget
Revenue
Monthly + Annual Report
Transport
PHARMACEUTICAL
WARDS
KITCHEN
PHARMACEUTICAL
LABORATORY
X-RAY
MATRONS
TRANSPORT
ADMINISTRATION
O
F I N A N C E

files and admission files. "*It is even better if one is calculating bed occupancy because beds state does not change all the time*" one superintendent explained, he said that the calculation for bed occupancy was relatively simple as the number of beds is constant. Calculations for indicators such as the average length of stay were more complex as variable data regarding the number of in-patient days, discharges and deaths were required. The case mix method and low level of data integration meant that superintendents often had to find files three times before attaining an indicator. *"The system has the potential to record all the facilities used in hospitals but strong computing skills are necessary in order to use the facility optimally. Without these computing skills it can be difficult to get reports with ease*," one superintendent remarked. This statement reveals that the system is not as user-friendly as it could be and that it is not optimally integrated. It appears that for higher level reports the system cannot provide the information needed on a 'push-button basis'. On the other hand, daily reports and summaries of admissions and discharges were computed without any problems.

One superintendent who had been in contact with the system for only three months felt that it was difficult to appraise the system fully as he had not had enough time to explore and use it. Nevertheless, he regarded the system as useful for people with good computer skills. He was positive that improvements would occur with time while the paper-based system transferred to the electronic system: *"It will take time for most people to grasp how the system works, the system and the staff will have to adapt to one another".* He also stated that the system could not run smoothly overnight and that researchers and other stakeholders needed to be patient. He continued "*I hope you do not expect the system to run smoothly over night, it is going to take time as we need to transfer the paper based system to the electronic system*". This encouraging and positive statement shows that some people understand that the system needs to be given time for adaptation and customisation before effectiveness and efficiency is realised.

Superintendents' Perceptions of the System's Effectiveness

Some superintendents expressed a practical effectiveness in that they got reports on patient admission, personnel and finance. They also obtained outcome indicators which required a

case mix method as explained above in order to generate high level reports. The system was perceived as effective especially in terms of simple and immediate information needs such as admissions and discharges. At times the network became so slow that people waited for between 6 and 15 minutes before the execution of requests. Notwithstanding, the system provided the information requested, which was determined by the capabilities of the system: "*One cannot expect a system to provide sophisticated statistics if there is no such capacity built in,"* one superintendent said. This statement reveals that superintendents who did not have enough experience with the system were uncertain about the facilities available. One frustrated superintendent *complained "I usually get all the statistics I want but this damn thing needs somebody with better computer skills to drive it!"*

Superintendents explained that information management knowledge and skill were important if the system was to be useful. It was regarded as difficult to access data from the system without such skills. The simultaneous use of both the paper and electronic based systems was identified as problematic as it duplicated functions. Health workers recorded information on paper, which they entered into the system later on. Overall, the superintendents interviewed were positive about the system and reported that the system assisted them to perform the following activities: verifying information received on paper and randomly checking revenue and other financial aspects whenever needed, which assisted in meeting revenue collection targets set by the department of health. The down sides of the system were that when it went off line several weeks caused backlogs in information updates and wasted time; technical support was often not available soon enough (resulting in some hospitals having a non-functional system for three to six weeks.) The system could not provide information on other modules such as X-Ray, kitchen, laundry, pharmacy and laboratory, all of which were completely run by different systems (both paper based and electronic). This problem interfered with information integration and completion in a negative manner. In this regard there were three different systems running in the same hospital: an electronic laboratory system, a pharmaceutical paper system and the newly implemented HIS.

The Matrons' Views of HIS in Supervisory and Control Roles in Hospitals

Matrons identified their main information needs as related to supervision and control of the management of patient care in the hospital. When questioned whether the system provided such information needs, the discussion revealed both positive and negative responses. On the positive side matrons agreed that it took them a simple click of a button to access information on aspects such as admission and discharges in the ward. If the information had been submitted on paper they could verify it while in their office without needing to dash from ward to ward. In this regard efforts in checking and retrieving information were reduced by 20%. The matrons were concerned about the accuracy of the information that they obtained from the system. Periodically, they conducted information audits by checking the records and registers used in the ward for admission and discharges against the electronic reports from the system. In some instances discrepancies were identified.

Matrons were generally of the opinion that the system was too demanding and wasted too much of nurses' time. One matron remarked that the system increased nurses' workloads*: "Nurses have to write in the patients' paper record and sit in front of the computer to capture the same information."* Ward nurses appeared to take more time on recording information than on patient care. One matron said *"computing information is a non-nursing duty, it takes up a lot of patient care time*". Despite the positive functions that the system could perform, matrons had conflicting perceptions about the system, pointing out the negative aspects of minimising patient care time away and duplicating recording activities. One matron suggested, in direct contradiction with the opinion that the system would make the nurses workloads lighter and do away with the need for ward clerks, that ward clerks were more necessary than ever in order to reduce the duplication in the wards. "*They said that the system was going to make our work easier and we need to do away with the ward clerks, no the system makes our work difficult it is now that we need ward clerks*" one matron remarked. Another matron expressed dissatisfaction that the system could not provide a matron's report. As far as the matrons were concerned the system only increased efforts around patient records. It appears, from the matrons statements, that their expectations were high with regard to the system's potential, and that they were in general, disillusioned and disappointed by it.

The system's only effective aspect was that it allowed them to check admissions and discharges in each ward. However, even though the system was generally considered problematic and information needs were not met, matrons were against the idea of totally removing it away from the hospital. Some matrons indicated that the system gave them a feeling of keeping up with the times and technology but there was a need to sort out its problems and gear the system up for their management information needs.

The Influence of HIS on Revenue Collection in Hospitals

The information needed by revenue clerks was somewhat similar to information needed by superintendents and matrons. Revenue clerks needed information on: admissions; dates of patient discharges, used for billing; the patient ID or hospital number; the patients Medical Aid details if any and the number of patients according to criteria defined in terms of billing: H1, H2, and H3. H1s are those patients who are pensioners or indigent and unable to pay fees; H2s are patients who are able at least to pay the R15 .00 standard fee for all outpatients. As well as this revenue clerks needed data on the number of out patient visits in order to analyse the intake and revenue collected on a particular day; the cost and expenditure incurred in hospital; the budget allocated and the revenue target as set out by the provincial office.

Discussion about whether the system was able to meet the information needs of revenue clerks varied from hospital to hospital. It appeared that the discussion was influenced by whether there was an electronic billing system before the new system or not. For hospitals which had an electronic 'financial management system' prior to the new system, revenue clerks did not appraise the billing system provided by the new system positively, perhaps because they had something to compare it to. For this group the system did not provide the information they wanted in an acceptable format and they found it difficult to get all the information they needed. They often found themselves resorting to using calculators rather than accessing information directly from the system, as they found it too time-consuming. On the other hand, they admitted that it was easier to obtain information from the system without visiting the information centres in the hospitals.

Like everybody else, revenue clerks found it time consuming and problematic that the system went off-line at times, particularly in terms of having to update the information at a later stage. A recurring problem was that a patient who had left the hospital was not discharged on the system. Revenue officers would find that patients in the ward according to the system yet on further follow up would find that they were no longer in hospital. This created problems in terms of billing, as the length of a patient's stay was used to bill Medical Aid patients. If a patient was not discharged from the system, over billing could occur. One revenue clerk said, "*It is embarrassing when somebody rejects the claim you appear as if you are fool, nurses need to discharge patients immediately from the system"*.

For those hospitals which had no system before HIS was implemented revenue clerks appeared more satisfied that the system was able to provide the information they needed, perhaps because of a lack of comparisons. Problems related to billing were apparent in this group too. They were able to get information from all the centres without leaving their offices. A times they found it time consuming to check and bill patients because the system could not provide specific name searches, making it necessary to go through the whole list. Another general problem experienced was the inability of the system to cancel an incorrect bill generated as a result of inaccurate information. For instance, a clerk would bill a patient who had left the hospital but according to the system was still there, only to later learn that the patient was discharged two weeks previously while the system was down. The system did not allow them to erase such systemic errors and caused problems in reconciling the actual revenue collected. One revenue clerk reported that these discrepancies were difficult to reconcile and explain to auditors

The flow of information from the OPD to the admission ward and other parts of the hospital was not clearly defined. In some instances the information was incorrect or incomplete in that it did not include all the procedures carried out for the patient. One clerk explained that there should be a defined patient flow in a hospital*: "I need access to theatre records in order to bill patients, especially Medical Aid properly."* He continued to complain that he failed to collect substantial amounts of money because theatre or ward nurses did not report on the procedures carried out. These statements reflect what Coiera (1997) called 'care pathways'.

According to him a care pathway is a process of breaking down treatment into sets of stages, each with their own entry and exit criteria. *"I sometimes find that there are outstanding accounts according to the print out which I cannot reconcile, if auditors can come it can be difficult for me to explain the discrepancy caused by the system"* one revenue clerk reported. The revenue clerks' opinions suggest that there is a need for care pathways so as to assist them in avoiding error.

It must be noted that notwithstanding the revenue clerks' concerns about poor reporting from the wards, it is difficult to allow them access to patients' records due to confidentiality and security reasons. There appears to be a conflict in principle between the revenue clerks' duties and health workers' professional and ethical functions. The system is designed in such a way that it protects confidential information from being accessed by the revenue office, which in turn could lead to financial frustration if incomplete information about a patient's medical procedures is accessed by the revenue clerk.

Revenue clerks used both receipt books and the electronic system to acknowledge money received. At times, discrepancies were encountered between the respective sources, at which stage both could be used to verify and validate information. Another concern for the revenue clerks was the use of a different financial system by the regional and provincial offices. This meant that the same data was captured three times: once on the *paper system;* once on the *electronic system* in the hospital and a third time at the regional offices on to the main *financial system* of the province. The revenue clerks felt that this triplication of their work was a profound waste of time. It was impossible to transfer the electronic data directly because the HIS and the provincial systems were incompatible.

On a more positive note, those revenue clerks who never used an electronic system before praised the system for: making patient's records easier to retrieve; making intermittent check ups in OPD simpler; making checking up on admissions and discharges from the ward more efficient when the system was working well and the information complete.

The HIS Impact on the Registration and Admission of Patients by Clerks

Clerks perceived HIS as changing and improving the work of the registration and admission of patients by clerks in OPD. Clerks in all hospitals visited responded positively about the system, and proved to be the group whose functions were most significantly improved by the system. The registration clerks in OPD reported that the system improved their work in the areas of: retrieving returning patients' records and checking the accuracy of the information provided by the patient in the second visit. The clerks reported that the computer could easily trace returning patients' records, which made it easier for them to link it with the manual system on the shelves. As one clerk explained *"When a patient comes for the first time I record his or her particulars on the patient's card which remains in the OPD as well as in the computer. I file the paper record, so I have to use both systems. It is time consuming but is useful when the system is off-line. It is even easier when the patient returns for a second or third visit because the computer tells me where to find the patient's card and OPD record on the shelve*." When the clerks were encouraged to attribute a numeric value to the perceived improvement in OPD, they agreed that the system reduced the time taken to find OPD cards by 20% to 50% for second visits. Even if a patient changed his or her personal information the system made it easy to detect that, for example, that person still owed another hospital in the province. While such information would not prevent them from admitting the patient they could at least trace the patient. The system made it easy to search for patients by surname, ID number or district. If the patient was admitted to another hospital, it was easy to get information from that hospital through the system. This process, however, was not successful every time as some hospitals do not use ID numbers as hospital numbers for patients. This suggests that there is a problem of coordination and synchronisation in some respects, such as patient Ids, between hospitals in the province.

It was not clear how long the paper based and electronic systems would have to run parallel. One clerk said, "*It will go on for two years, I guess we cannot stop the manual system because this system is unreliable it is on and. Patients complain , we cannot say no, we are not working the machines are down. I know in some places that is done for instance in a bank they usually tell you that we cannot help you our computers are down. You cannot say the*

same to patients we deal with emergencies and sick people, otherwise they will take us to court, remember these days patients have rights". This statement highlights the different dimensions of the Reality Gap (Heeks et al. 1997) between formal rationality and behavioural reality surrounding systems designed for various contexts. When the system was down because of power cuts or technological problems clerks used the manual system and updated the electronic one later. This duplication process was considered a waste of time as there were no extra staff to update the backlog caused by the failure. "*It is sometimes difficult you cannot say to patients wait I am updating my work, since the computers went down last week, patients sometimes become fed up with us if the system goes down in the middle of clerking them"* one clerk explained. Again this statement reflects that the interaction between humans and computers generates a number of conflicts between health workers and the general community. The conflicting expectations of the system and the patients raise questions, which need to be asked in preparation for the computerisation of health in general, such as to what extent will health computing generate ill feeling between patients and health workers? Will health computing be readily acceptable to patients? How will quality of care be measured?

One clerk estimated that the paper based and electronic systems would have to operate concurrently for three to four years. He based his estimation on the experience of changing from one manual system to another. It took them at least three years to rely on the new system, although even after that time there were occasionally patients whose records were still in the old system. It remained unclear whether it would be best to get more staff to transfer all patient records into the new system simultaneously. While this would be the idea way to make the transition smooth and short, it is most likely not cost effective. It is also possible that transferring all out patients' records at the same time would lead to system overload and failure. Perhaps the accumulative record transfer on a patient by patient visit was a good way for the system to adapt. These areas need careful analysis. Shortening the use of parallel systems may reduce duplication of activities thus reduce waiting time and improve the quality of data. This issue is revisited later in this report.

According to OPD clerks negative aspects of the system include the use of parallel systems; the system going off-line and an inability to erase revenue related information if a mistake is

made. *"It is difficult if I make a mistake such as charging H1 only to find that the patient cannot pay. What can I do no rubber or tippex I have to explain to the revenue clerks. When the amount is small I just pay for it myself because it is easier than explaining to the revenue clerks,"* one clerk recounted. Once again the reality gap emerges implicitly from such a statement.

The Role of HIS in improving Patient Care Management by Nurses and Doctors

The nurses listed the following socio-demographic data as necessary to the execution of their duties: the personal particulars of the patient (name, ID number, address, next of kin, age, occupation, sex); health related information (medical/health history, diagnosis, lab results, treatment); whether the patient was a private patient or not and information about the medical condition of the patient (vital signs or biological indicators, temperature, pulse, blood sugar levels, blood pressure). In order to nurse a patient according to the diagnosis, information related to the nursing care plan is needed.

When discussing how well the system provided for their information needs, the nurses made it clear that the system successfully provided socio-demographic data. Nurses were encouraged to rate the quality of information provision. On a scale of 1-10 the system scored 7-8 points. The nurses explained that demographic data improved because the system compelled OPD clerks to fill in all information fields. *"Before the system,"* one nurse reported, *"clerks would fill in the ID, the name and the address of the patient only, leaving the rest up to us." Like* the OPD clerks, nurses reported that the system was functioning well in the admission and registration of patients.

The system was not well appraised with regard to carrying out functions related to health/clinical data and patient management. The system did not provide codes for all diseases, conditions or procedures, such as burns, termination of pregnancy or classification of fractures. "*We sometimes look for a diagnosis and we do not find it"* one nurse remarked. When the diagnosis or code cannot be found they left it blank. "*Sometimes the machine does not allow you to pass the code field, you give up and use paper system only"* one nurse stated.

This suggests that the information in the system is incomplete and may lead to inaccuracies if nurses are forced to fill in any code so as to proceed to the next step. "*For instance sometimes the patient comes from Zimbabwe and the computer refuses Zimbabwe"* one nurse remarked. Nurses reported that when patients from countries other than South Africa were admitted to the hospital, they recorded them as South African because the system refused to accept the names of other countries, such as Zimbabwe. This suggests that not all information captured in the system is accurate. It appears that with this prevalence of inaccuracy in data an intensive audit is necessary before the computerised information can be considered reliable. A closer look at the system reveals that the system does in fact provide the names of other countries as well as an option to fill in a name which the system does not have. This demonstrates that some nurses lack the knowledge and skills to record the information accurately. Another complaint was that some of the modules were not in the system. "*We shuffle between computer and paper records for instance you look for the patients card in the computer you find it but you do not get information on X-ray and laboratory and you need to go for the paper system"* one nurse complained. She continued "*sometimes this waste your time"*. The delay in the development of the remaining modules of the system appeared to frustrate nurses.

Another problematic area for nurses was discharging patients from the computerised system. Like the revenue clerks, nurses reported that sometimes the system did not discharge patients. One nurse reported, "*Sometimes you admit the patient into the computer the machine refuses and tells you that the ward is full but the ward is not full"*. The discontinuity between physical and system-recorded space was directly linked to the system going off-line for two to six weeks at a time as reported earlier. The nurses complained that it was not easy to update the backlog caused by the system a problem also highlighted by the matrons. As well as this, nurses did not update the system (when it was online) when patients were discharged. This reveals that the system is poorly updated about developments in the ward, which further reflects the inaccuracy of data. It is necessary to ask whether the system errors (such as when patients are erroneously discharged or not) are intrinsic or are caused by human error. This means that human-computer interaction and the problem of computer skills needs attention. These issues are further interrogated later in this report.

A general problem appeared to be the system's tendency to go off-line. Nurses further reported that when a computer in one ward stopped functioning because of a technological fault, nurses would queue up in another ward to capture data. This is particularly interesting because it shows that despite nurses' complaints about the system, they were fairly captivated by the idea of a computerised system. If this were not the case, surely they would have chosen to use the paper system instead of going out of their way to another ward to use the computer. It was observed that most ward computers were problematic and in many instances did not work. Nurses rationalisations for these problems varied. While some felt that it was related to poor computer skills and basic human error, such as pushing the wrong button and not knowing how to correct minor mistakes, others thought that there was too much information for the system to handle. One said, "*if it gives me problems I just switch it off*". All of this shows that there is a profound lack of skill in the proper management of the system the constant rebooting is concerning and reflects poor understanding of the system. These issues are revisited later in this report.

The nurses raised one issue, which they considered quite problematic. The system uses a concise definition of a child: a person under the age of thirteen. The system automatically calculates the age of the patient based on the date of birth which is entered. If a patient who is thirteen years and a few months old is admitted, the system classifies him or her not as a child, but as an adult. The nurses were concerned about this, because the system defined older children as adults when they were clearly not as socially mature as adults. This concern can be associated with the impacts of imposing a structured, rational information system on social/health practice and behavioural realities, as suggested earlier. It remains to be seen whether this problem can be solved by readjusting the system itself to give nurses greater leeway in the definition of a child, or whether nurses themselves will have to accept the system's rigidity.

The definition of a child was related to the system's pre-allocation of beds in the wards according to medical categories and gender. This was problematic, especially in small hospitals where there was no clear bed demarcation based on medical categories or gender. "*When there are no beds in the male ward we sometimes admit an emergency in the female*

ward, but the machine refuses to accept a male patient in a female ward" one nurse reported". She continued, "*for instance one day there was a male patient who was very sick there was no male or female bed we had to admit him in a maternity ward the computer refused to take a man in a maternity ward but we ignored it and we used manual system"*. It seems that the design of the system was based on a big hospital and does not take in to account the bed shortages experienced by smaller hospitals. It is clear that the system needs to be able to adapt to different sized hospitals. The pre-allocation of beds demonstrates the short coming of piloting a system in big hospitals and implementing them in small hospitals. It is clear that a generic system becomes unique in an individualized setting: the same computer system changes when implemented in different hospitals. This suggests that systems should be flexible and supports Coiera's argument (1997) that computer systems should be flexible in order to add and remove modules so as to avoid obsolescence. He further argues that rigid systems fail to accommodate changes in the objectives and information needs of users and organisations and therefore eventually perish. Health workers' dissatisfaction with the system's rigidity in the allocation of beds clearly threatens its success. It should be considered whether such responsibilities as allocating beds should be controlled by a computer system.

The discussion with midwives about the advantages and otherwise of the electronic system were generally similar to the opinions of nurses from the general ward. Two criticisms were voiced: the first that the system did not provide for the monitoring of the progress of labour; the second that the system did not generate a matron's report.

Nurses were particularly incensed about the thorny issue of user IDs and passwords. Not all nurses were issued with user IDs and those that were not, found themselves in disadvantaged positions, as other nurses refused to allow them to use theirs. Further, if the nurse with the password was not on duty, nurses had to go to other wards to 'borrow' passwords This appeared to generate animosity and conflict, as those without passwords felt that they had an inferior status to those with passwords. Some nurses who lacked user IDs developed negative attitudes toward the computer system, such as the nurses who complained that she did not have anything to contribute to the debate because *"I do not have a password what can I say? Ask those who can use the system. I do not know why the system administrator has not given*

me a password, it is not nice to go around and ask 'lend me your password' like a beggar"

For security reasons every one should have her or his password. Hospital information systems are hierarchically structured and managed for confidentiality and security reasons. The system is structured in such a way that different staff members have different access permits to the system. For example, HIV/AIDS information, for confidentiality reasons, should only be recorded and accessed by senior personnel. Nurses reported that they could not enter or access HIV/AIDS information into the system. It is clear that the system of 'one person one password' is not implemented. It is problematic that passwords are loaned, but at the same time it is not clear what staff should do if the two people with passwords are not at work. This is discussed further later in this report.

Maintenance of HIS in Hospitals and Systems Coordinator

The need to manage the system introduced a new cadre of professionals to the hospital setting. Two to three persons in each hospital were selected from administrative and nursing staff to co-ordinate the system. The Hospital Information Systems Administrator (HISA) hailed from the administrative side, while the Nursing Informatics Co-ordinator (NIC) was chosen from nursing staff. They had well defined job descriptions, as provided by the Department of Health and Welfare in the Northern Province. The co-ordinators themselves described their jobs as challenging and difficult. The systems administrator was responsible for maintaining the system and trouble-shooting. While some attended training courses others were taught while the system was being installed. One reported "*I learnt the system on trial and error I never got serious training I can say it was an orientation*" *"We try this, we try that and when we see it working we learn."* They reported that in some instances they lacked the in-depth knowledge needed to solve problems. When they encountered insurmountable technical problems they called a centre for technical support based in Pietersburg, WHITOC, which provided assistance via the telephone. This proved useful only if the problem was small. If it was bigger, somebody from WHITOC would need to come to the hospital to assist. The systems administrators agreed that it was not necessary to have Information Technologists as they believed that if they received more training they could manage. The

enthusiasm and positive attitudes reflected by the systems administrators led to great problem-solving initiative*: "We do what we can, if we cannot solve problems everybody must stop using the system. We have to make it work, it is our job"* one administrator said.

The systems administrators were responsible for providing passwords. They explained that they could not create passwords as they did not have sufficient knowledge of how to do so. They had collected the names of those needing passwords and sent them to WHITOC in an attempt to rectify the problem. However, because passwords and user IDs need to be created one by one, it is a time consuming process. Systems administrators agreed that if they received more training they could solve these problems themselves.

Systems administrators reported that when the system was live and everybody was working on it they became very busy as many people encountered problems, some of which were skills related. One system administrator related: *"Sometimes I will ask a person to click and she will reply 'Click? What? Where? How do I click?*" Computer jargon appears to complicate matters for system administrators, as health workers are not familiar with it. This once again highlights the urgent need for general computer knowledge amongst health workers as a base for implementing systems. This issue is further analysed later in this report.

The NICs reported that they felt responsible for the nurses without passwords as all staff needed access to the system in order to do their work. "*I feel bad because people say why so and so and not me, it is like I pick and choose"* she reported. They also reported that technophobia was a major problem amongst health workers, particularly older nurses, and that there was a general resistance amongst nurses to using the system. One NIC reported that she had to persuade nurses to use the system, because it would not work if people refused to use it. Hopes were high that staff would get used to the system and learn how to use it. *"I had to persuade them to use the system especially the old ones because this system has to work and if people do not use it, it will not work. I also did not know much about computers but I tried it was not easy it needs patience"* one NIC reported. Overall, the systems administrators agreed that the system was good but that it needed time for staff to get used to it.

The Organisational Change in Hospitals as a result of HIS

In both interviews and focus group discussions, most interviewees reported that the computer system generated both negative and positive perceptions about how the hospital environment changed. On one extreme, a matron exclaimed that everybody was happy about the computers and nobody would allow it to be taken away. "*Everybody is happy about computers,* one matron reported, *she continued we would not allow anybody to take it away from us"*. Staff in some hospitals were excited about the computer system and perceived it as an introduction to the information technology era. The need for ward clerks to manage the input of data was reported several times. This was even the case in hospitals that already had ward clerks, which reported a need for more. The computer system was reported to have generated delays in areas like OPD, especially during the early stages of computer organisation contact. The electricity problems experienced generated a need to consider other means of ensuring a sustainable power supply. Nursing stations found themselves in need of more office space. The points where nursing station were situated were considered ill-suited for constant nursing duties because some of these points were far from the wards in the corridors. Nurses did not make it clear whether they thought that these stations should be relocated to the wards or whether they would disturb patients at night.

In so far as the integration of information, communication and functions between different disciplines was concerned there was no change impact observed. Doctors were generally unaffected by the system as most of them did not use computers. Hospitals had experienced both good and bad fruits of information technology and were keen to move forward in creating solutions for the problems they experienced.

The Role of Pre training and General Training on HIS use in Hospitals

The training was appraised as both good and bad, depending on the informants. Those with previous computer knowledge tended to consider the training poor and basic. Those who had no computer skills at all or who had never touched a computer were excited and described it as good. Most interviewees commented that follow up training was necessary, even though

training manuals were provided for revision purposes. "*You cannot go for a computer training for three or seven days only and you are expected to know"* one person explained, she continued *"It was the first time for me and was done before the computer was installed by the time it arrived I had already forgotten about click click"*. It was agreed that everybody who was to work with the computer should have received training as those staff members who did not attend training found using the computer system difficult. *"It was better if two people are trained thoroughly so that they can train us daily or on the job"* one nurse said. *"I work with the patient and I have to ask somebody else to capture the information into the computer it is awkward"* one nurse complained. Overall, the training of trainers was regarded as the best solution for building capacity on computer skills.

Even though some nurses had computer skills from courses offered by a company in the area. These courses were so long before the introduction of the system, and that their skills were already rusty. Nurses were keen to take more in-depth computer lessons, which extended beyond the scope of the HIS to a desire to learn computer skills as part of their nursing training. "*Why can't we take computer courses like in Britain and elsewhere? Today in these international nursing journals we read about nurses learning computers as part of their training"* one nurse asked. It was not clear whether this nurse was referring to computer lessons or nursing informatics in general. However, this shows the need for the general computer and informatics training for health workers.

Part Two: Qualitative Explanatory Report

Relationships to the computer

The responses of the superintendents, matrons and nurses gives light to the fact that *proximate positioning* is the key to the use of the new system to get the information needed. It appears that the system will be used more by those health workers who are proximal to the system than those who are distal from it, as the responses of the superintendents and health workers demonstrated. Anderson, *et, al.,* (1994) observed that the frequency of use of a system can affect attitudes towards it. Non users and infrequent users may not be familiar enough with

the new system to realize its strengths and short comings. This assertion is supported by the findings of this study, as many key informants suggested that the system needed more time to integrate before it can be appraised as either good or bad.

Most superintendents reported that they used the system to retrieve information in both its adaptation and assimilation phases. Nurses also reported using the system often, particularly those who had user-names and passwords. The same was not true for those nurses without user IDs. It is clear that those nurses with passwords were 'positioned' nearer the computer and thus were better able to use it. Those nurses without passwords did not use the computers because of their distal positioning. The hypothesis that can be generated from this data is that distal or proximal positioning influences the effectiveness and efficiency of HIS. This also suggests that information for hospital management and clinical care management is available to managers and nurses in relation to their position to the system.

The matrons and nurses reported that since some information that they needed was not provided by the new system, integration was a bit difficult. For instance, for a nurse to fulfil her nursing activities she needs information on X-ray reports, laboratory results and pharmaceutical information to check whether treatment has been issued or not. This information is still on a paper based system for most hospitals. They were only able to glean biological indicators and information regarding discharges and admissions from the new system. Integrating paper based and system based information to develop a nursing plan was not easy, as the nurse would have to shuffle between the two systems. This was a concern for matrons too, as they received information from both systems and needed to integrate it for reports, control and supervision. Revenue clerks also needed a degree of integration particularly to bill patients and to check OPD numbers and the categories of patients who had visited the hospital. The revenue office was able to integrate information from OPD; admissions and discharges and diagnoses from the ward. It appears that there was a problem with regard to procedures done. Once again at this level it appears that there is a problem of information integration for revenue offices. This also raises questions regarding the level of integration.

Associated with problems of integration is the fact that at the time of evaluation, the system was still developing. Some modules were not yet included in the system. Nurses were not happy with the pace of the development of other modules and the system was generally regarded as unsuccessful. What becomes clear is that health workers did not understand that the system needed a bit of patience from them. Once more the data reveal that a system's effectiveness is measured by the level of integration. Giuliano (1982) explains that the integration of health/medical information in a system helps to create a "virtual office" with boundaries related to task and information flow rather than to traditional functional departments or occupations. Integration facilitates the utilisation of patient information in patient care management. Without integration the flow of information is interrupted and made tedious as indicated earlier with the superintendents' calculation of indicators. It is very important that the system should be integrated for the easy manipulation of data in the process of care. This raises a question: when is the system expected to meet the integration process, when it is fully developed or while it is still developing? One hypothesis is that the effectiveness and efficiency of the system is influenced by the level of information integration. As well as this, the effectiveness and efficiency of the system will be assessed by the efforts put in to integrate information for nursing, medical/health, management and revenue collection.

Information Required and Practice

The data revealed that health workers in general and managers in particular would be able to access information if they had the competent skills to drive the system. This is reinforced by the fact that those people with better computer skills were able to use the system optimally to get the information they needed. Some superintendents reported that they were able to obtain outcome indicators through a long mix method, while matrons reported being unable to get such reports. This demonstrates vividly that in order for managers to retrieve information, computing skills are crucial. Matrons and nurses reported that all they could obtain were daily reports, which means that computing skills are crucial for higher level reports, including hospital outcome indicators. Another important point that emerged from the data is that practice assists nurses and system administrators to master the system. The nurses and

administrators reported that they learned by trial and error, which helped them resolve problems without outside help. This suggests that practice evidence (as per Tripodi 1983) can be considered a measure of effectiveness and efficiency of HIS. This further indicates that everybody needs to practice in order for the system to be efficient. It seems that the more people practice the more skills they acquire making them able to interact with the computer and the system as a whole.

Another important fact that emerged form the data in terms of proximate positioning was a lack of understanding that a hospital information system is hierarchically structured and that its management is also hierarchical. Some nurses reported that information on HIV/AIDS cannot be captured. The need for security and confidentiality means that the system will not allow unauthorised health workers to access HIV/AIDS information. As well as this, a revenue officer raised the same issue in terms of accessing procedures done in the ward or by nurses. These two instances demonstrate that staff need to be educated regarding how these systems function in order to reduce ignorance related complaints.

Interdependency and Integration of Information

The integration levels were dealt with on two levels: the internal and the spatial (or external). Superintendents found both levels of integration critical to their responsibilities in the hospital, whereas other staff categories were more concerned with the internal integration of information, which makes some types of analysis in relation to patient costs, outcome indicators and revenue collection easier. In order for the superintendent to audit revenue collection, for example, information on admissions, discharges and OPD numbers must be integrated and compared with the revenue generated. Such integration was not possible in all areas of the hospital as some systems, such as pharmaceutical and laboratory systems, were not yet integrated with the new system. External integration enabled the superintendent to trace transfers in and out of the hospital as the new system records information concerning transferred inpatients from other hospitals, which was vital for further patient management.

While information concerning transferred inpatients can be obtained from other hospitals it is usually incomplete and only demographic data is accessible. Although diagnoses are also sometimes available, discharge summaries are not obtainable. It remains unclear whether the incomplete nature of information from other hospitals is due to poor discharge summaries or security reasons. It appears that information can be integrated at supers' level only though great effort. The interdependency of disciplines in hospitals is a driving force for integration. For Anderson, *et, al.,* (1994) integration of information in a system strengthens interdependency and understanding between different units in a hospital, as boundaries are removed. Integration encourages sharing and understanding of different values, norms and discourses used by different disciplines. This helps health workers to view the system as a whole instead of as several departments. Hospital information systems have the potential to promote comprehensive patient care if they are structurally integrated.

Interaction and Sharing of Information and Technology

Health workers did not establish any general interaction in using the new system. The reasons for poor interaction (both internally and externally) are two fold: both *systemic* and *attitudinal.* The system did not provide them with interactive facilities, even at professional level. Some nurses complained, for instance, there was no facility for the wards to notify the X-Ray departments that patients had been booked for X-rays. Despite this, one superintendent reported that he used electronic reminders on a regular basis. It is clearly impossible to interact with units whose modules were not yet developed. However, the general lack of knowledge about the facilities provided by the new system and poor computer skills amongst health workers suggest that even if an interactive facility was available health workers would not have been aware of it. If the facility is made available whose responsibility would it be to develop awareness and utilisation the company that implemented the system or the government? Further contracts should be arranged beyond implementation to develop these facilities for and with health workers. It is a fact that companies are given time-frames to implement their systems and to provide pre-implementation and implementation training. The research suggests that training should be continuous over a year so as to take health workers through the adaptation and assimilation stages and up to the blending stage. According to

Anderson, *et, al.,* (1994) communication amongst health workers affects the adoption and diffusion of technology in the hospital environment. This suggests that poor interaction using the technology limits chances of adoption and diffusion of that technology resulting in poor system use.

Poor interaction impacts on the effectiveness of the hospital information system. This is illustrated by the nurses' report that because they could not contact the X-Ray department the system was less effective. The results of this study are in line with the perspectives outlined in models of change earlier in this report - *complex social interactions as determinants of system use*. This further affirms that hospital information systems should allow complex interaction in the management of patient care in order for them to be effective.

Attitude related problems of interaction and information-sharing are complex and compounded by power struggles and proximate positioning. As explained earlier, conflict and animosity was generated because many health workers, particularly nurses, did not have user-names and passwords. This problem limited interaction with and about the new technology amongst nurses in general. In doing so, 'marginality' developed as nurses who could not operate computers distanced themselves from those who could. Lack of information sharing leaked through attitude related statements of those who could not access computers.

The power gained by nurses with passwords was a source of resentment to the non privileged. This threatens the use of the new system in the future. Some nurses did not give chances to others to learn to use the computers. This monopoly is an unexpected and undesired consequence of the system, which can be associated with novelty of the system and may lessen with time as staff get used to it. One possible solution would be to provide computer laboratories for block training in hospitals where staff can have unlimited time to learn. This may not be, unfortunately, a realistic suggestion. Despite these problems enthusiasm generally prevailed amongst health workers.

Control Group Report

Three of the non implemented hospitals functioning as control groups were visited. The method of enquiry in these hospitals resembled that conducted in implemented hospitals. Key informants were interviewed and focus group discussions were conducted. Health workers in these hospitals shared the same information needs as those in computerised hospitals. Problems mentioned about the present paper based system were: duplication of files, files getting lost, problems in tracing patients that still owed the hospital and file storage problems. With regards to how effectively the system was providing for their information needs, they reported that only with a lot of work to organise the information from a number of paper records was it successful. This was considered more time consuming when writing monthly and annual reports. Some staff members expressed reservation with regard to the computerisation of hospitals. Some, particularly clerks, were afraid that the system would make their jobs obsolete and that they might be retrenched.

All non implemented hospitals had computers that were used to process administrative activities. In two of these hospitals, computers were not in use because they were out of order and were referred to by clerks as ornaments. In one hospital the matron explained that their computer changed their style of work as they could develop patients records and charts for office use and type letters without their old type writers. She felt that the introduction of more computers would solve some of their problems. She had heard from matrons in other hospitals that had been computerised that work life was improved. This suggests that health workers in computerised hospitals exaggerated its successes and minimised the problems they experienced. This is concerning because it builds high expectations for those who have not yet encountered the system and may lead to disappointments and low morale once the system is implemented.

Prior to implementation or during pre-implementation training health workers should be alerted to the realities of working with a computerised system so as to help minimise the gap between expectations and reality. Heeks, *et, al.,* (1997) argue that an integral part of a successful hospital communication information system lies with a proper understanding of

current realities. This makes it clear that both implementers of hospital information systems and project leaders should encourage participants and users of the system to articulate what they think they will do and discuss the reality of what could happen once the system is in place. This may bring about better acceptance and a more in-depth understanding of challenges lying ahead of systems users rather than creating high expectations and false impressions as has been observed to be the case earlier in this report.

Another important finding is that a significant number of health workers attended computer training courses voluntarily without support from the government. This is impressive as it reflects health workers' realisation of the need to be computer literate. This is valuable despite the fact that they felt that they had lost these skills due to lack of practice.

On the whole it appears that paper based systems create a number of systemic problems in these hospitals. The evidence reveals that despite problems which the computerised system has brought to hospitals, non systematised hospitals would gain in certain areas by changing their work environment. It is clear that the hospitals which had not yet received HIS were fairly keen and enthusiastic about getting the system.

Limitations

The qualitative component of the study managed to provide better insight into issues related to the implementation of HIS. Its main shortcoming was that it did not get into an analysis of the software itself in order to examine issues of integration. Furthermore, some explanations for the system's limitations were based on health workers' opinions and available theory and not on data generated from software analysis. In the next round of evaluation it is important that the software is investigated to elucidate the problem areas identified. When health workers reported frustration in getting data from the system or utilising the system fully it was unclear whether facilities were provided to assist. Contradictions in reporting these problems highlights the need for further examination of the software itself when a complaint arises. These suggestions arise from the study conducted, which, it must be remembered was not aimed at evaluating the software.

Highlights

The study has demonstrated the level of the system's success in providing for the information needs of the users interviewed. The system is able to provide high level reports for superintendents. This was associated with the high computer skills of the superintendents. Daily reports and other low level reports were obtained from the system by every user interviewed. Although nurses managed to retrieve low level or daily reports, they found it difficult to do because of poor computer skills. Poor internal and spatial integration of the data in the system remained a major problem for all key informants. There are several factors associated with poor integration: poor computing competence amongst key informants; lack of co-ordination of patient IDs in the province; unavailability of other modules within the system and security and confidentiality issues. The findings also reveal that the system increased time efforts for certain activities and decreased time efforts for others. It appears that overall, time efforts were decreased with significant gains for other activities. The general lack of knowledge of how the system functions can be identified as the major source of increased time efforts in some areas. To conclude, there is an apparent qualitative association between how the systems perform and the level of computer competence amongst health workers.

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Appendix II

Effort/Effectiveness and Efficiency Model

Efforts - Median Time in Out patient - Administration

- amount of time now taken in clerking/processing patients in OPD
- amount of time and effort in retrieving patients record
- amount of time and effort devoted in filing /compiling a patient record

Efforts - Revenue collection - Administration

- amount of time and effort devoted to compiling patients statements and bills
- amount of time, effort and activity devoted to finding how much money is owed by patients
- to what extent has the present system increased the chances of identifying those who owe the hospital?
- in what ways can HIS maximise the collection of revenue or efforts in collecting revenue?

Efforts - Link Budget allocated and Amount Spent

- amount of time and effort devoted to linking budget to expenditure?
- amount of time and effort devoted to getting accurate data on links between budget allocation and expenditure
- amount of time and effort to put the data together and get it to managers as quickly as possible

Efforts- Cost per Patient per day - Administration

- amount of time and effort devoted to linking patient consumption and costs per day
- what efforts are devoted to compiling a report on patient costs per day

Efforts - Number of Referrals- Administration/ Health team

- amount of time and effort put into getting data of patients referred from other hospitals
- amount of time and effort devoted to retrieving all the information of referrals from other hospitals
- amount of time and effort put in to ensure the completeness of the patient record from other hospitals
- what efforts are taken to transfer a complete record with a patient to another hospital
- amount of time and effort devoted to checking whether the patient referred to the next hospital gets the services needed

Efforts - Average length of stay/Bed Occupancy/Administration/Health team

- what efforts are devoted to getting laboratory results (diagnosis/treatment)

- what efforts are taken in checking if drugs are available
- what efforts are taken in assessing patients condition

- what efforts are devoted to making a patient record complete for evaluation of patients condition
- amount of time and effort devoted to writing reports on patients
- amount of time and effort taken to calculate average length of stay
- amount of time and effort devoted to calculating this indicator
- amount of time and effort taken to organise or retrieve data for this indicator

Effectiveness - User needs- perception/opinion- Managers/Administrators/Health Team

- to what extent does HIS represent information needs
- what are opinions about HIS influence on some of the outcome indicators
- what are users opinions about accuracy, accessibility and timeliness of the information HIS provides: outcome variables
- what other appropriate services are made available by the HIS referral system
- what are the reasons for using the referral system
- what happens to the referral records of the hospital receiving the patient
- what is the extent of successful retrieval of patients record from other hospitals
- what is the quality of the information in the patient record

Efficiency

Efficiency is the combination of efforts and effectiveness. The data collected will be analysed to give results on the efficiency of HIS in achieving the objectives. The following questions will be asked when analysing the data:
- What is the relative proportion of staff time devoted to getting some or all outcome indicators?
- To what extent is staff time used to retrieve the information needed?
- What are the relative costs of using HIS to get outcome variables?
- To what extent are staff functions/roles structured to maximise HIS in achieving its objectives?
- Are certain staff characteristics more related to HIS than others?
- Are certain staff characteristics related to the failure to use HIS?

Appendix III
Table Hospitals for HIS Evaluation

NAME OF HOSPITAL	SELECTED HOSP	IMPLEMENTED HOSP
Blouberg		
Botlokwa H Centre	Early	
Donald Fraser	Late	
Dr. C.N. Phatudi		
Dr MMM Hosp		
Duiwelskloof		
Elim	Late	
Ellisras		
F.H. Odendaal	Late	
George Masebe	Early	
H.C. Boshoff		
Helene Frans	Late	
Jane Furse		
Kgapane	Late	
Letaba		
Louis Trichardt	Early	
Malamulele	Late	
Mankweng		
Maphuta Malatji	Early	
Mapulaneng		
Matikwana	Early	
Matlala	Early	
Mecklenburg	Late	
Messina	Late	
Mokopane		
Nkhensani	Early	
Phalaborwa		
Petersburg		
Sekororo	Late	
Seshego	Late	
Shiluvane		

Siloam	Late	
St. Joseph		
St. Ritas	Late	
St. Vincent		
Thabazimbi	Early	
Tintswalo	Early	
Tshilidzini		
Van Selden Memorial	Late	
Voortrekker		
WF Nobel	Early	
Warmbaths		
Witpoort	Early	
Lebowakgomo		

Appendix Table IV:
Baseline Prescription

Name of Hospital	Items Jan	Scrips Jan	Items Feb	Scripts Feb	Items Mar	Scrips Mar	B/line n/drg p/p	Trans-B
1	3,983	1,160	3,695	1,225	4,077	1,347	3.15	29
2	3,157	1,082	3,471	1,285	4,417	1,386	2.94	90
3	1,124	392	947	331	1,298	488	2.78	185
4	6,422	2,809	4,949	2,105	5,647	2,369	2.34	166
5	4,021	1,698	3,987	1,696	3,868	1,636	2.36	226
6	6,926	3,440	7,689	2,915	11,197	4,139	2.46	122
7	526	262	587	282	539	288	1.99	57
8	3,735	791	2,929	747	2,323	619	4.17	33
9	5,879	5,012	6,874	8,974	5,598	987	1.23	30
10	11,662	4,706	13,716	5,153	19,765	7,276	2.63	167
11	7,329	2,681	7,408	2,506	7,151	2,407	2.88	183
12	7,815	2,641	9,613	3,140	12,193	3,974	3.04	89
13	4,491	4,540	7,323	2,123	5,439	2,329	1.92	253
14	7,532	2,152	6,115	1,747	5,744	1,641	3.50	209
15	11,783	4,555	13,157	4,751	11,835	5,568	2.47	297
16	7,043	2,592	6,270	2,042	7,325	2,415	2.93	434
17	5,336	2,001	5,343	1,958	8,728	2,919	2.82	299
18	5,513	2,742	5,033	2,417	6,242	2,934	2.07	508
19	9,947	4,520	9,850	4,810	14,300	6,882	2.10	291
20	5,191	1,887	4,026	1,453	2,630	1,927	2.25	43
21	6,281	3,001	6,773	2,684	7,269	3,599	2.19	106
22	4,221	1,632	4,451	1,649	4,708	1,975	2.55	65
23	5,810	1,971	5,617	2,027	7,576	3,026	2.71	110

Appendix Table V:
Prescription for 3 months

Name of Hospital	Items m1	Scrips m1	Items m2	Scripts m2	Items m3	Transfers Trans-3
Implemented Hospitals						
1	3,848	1,223	4,945	1,555	5,308	35
2	2,462	907	2,599	1,132	3,186	101
3	1024	400	980	352	1278	100
4	6,068	2,178	6,270	2,527	6,698	150
5	4,178	3,269	4,554	685	733	149
6	6896	4340	7489	2815	11099	128
7	539	288	733	367	756	40
8	1,254	405	1,071	341	1,273	39
Non Implemented Hospitals						
1	2,725	1,078	1,970	716	2,175	31
2	10991	4689	13705	5159	19785	67
3	6,245	2,364	5,673	2,159	6,307	250
4	9,570	3,297	13,556	4,106	10,619	91
5	4499	4449	7409	2086	5426	220
6	7530	2209	5998	1742	5748	192
7	11769	4449	13168	4749	11836	135
8	5,457	1,788	5,874	1,946	6,161	228
9	5243	1999	5339	1987	8654	184
10	5515	2841	5104	2354	6149	173
11	1003	4841	9941	4715	13982	143
12	5087	2003	3961	1450	2586	145
13	6354	2997	5993	2704	7184	258
14	4226	1586	4526	1586	4802	116
15	5589	2005	5621	2101	7483	

Appendix Table:7
Prescription for six months

Nameof Hospital	Items m4	Scrips m4	Items m5	Scripts m5	Items m6	Scrips m6	n/drg p/p	Trans-6
Implemented Hospitals								
1	6,759	2,201	6,062	1,716	5,920	1,627	3.38	48
2	2,085	939	2,280	1,033	2,824	1,028	2.40	112
3	1023	410	915	286	1184	485	2.64	40
4	6322	2815	4885	2104	5456	2361	2.29	122
5	4013	1684	3895	1685	3858	1634	2.35	105
6	6924	3441	7578	2857	11143	4439	2.39	19
7	3983	1150	3586	1245	4023	1263	3.17	63
8	2099	1120	2101	1123	3012	1026	2.21	43
Non Implemented Hospitals								
9	2745	885	526	701	3045	603	2.89	43
10	11552	4801	13648	5103	19854	7289	2.62	30
11	7,324	2,594	7,401	2,514	7,145	2,489	2.88	216
12	7,815	2,478	8,965	3,471	13,125	3,847	3.05	52
13	4,454	4,423	7,401	2,012	5,321	2,319	1.96	213
14	7,454	2,089	6,042	1,741	5,688	1,712	3.46	292
15	10,885	4,723	12,875	4,689	11,768	5,466	2.39	232
16	7,102	2,415	5,278	2,106	7,401	2,445	2.84	295
17	5,332	2,018	5,406	1,949	8,712	2,989	2.80	183
18	5,548	2,689	5,101	2,413	6,216	2,875	2.11	321
19	9,876	4,487	9,902	4,756	14,287	5,993	2.24	587
20	5099	1899	4106	1503	2641	1873	2.25	138
21	6280	3157	6572	2748	7247	3368	2.17	297
22	4312	1587	4658	1589	4706	1969	2.66	112
23	5774	1956	5472	2104	7581	2987	2.67	135

Appendix VI

INTERVIEW SCHEDULE FOR QUALITATIVE DATA COLLECTION

Knowledge of information needs

What are your information needs ?
What do you expect from this system?
Does it meet your expectations ?

Experience and behaviour

Is the new system able to provide you with the information you need?
How long does the system take before you get the information you need?
Is it easy to get this information
Did you go for pre- implementation training
Can you talk about the training?
Were you satisfied with the training?

Time frame

How do you compare the new system with the old system?
How do you see this system functioning in the future?

Opinion/Belief

What are your opinions about computer systems and their efficiency?
What do you think this system has brought to your work environment?

Feelings

Are you happy with this system?
How do your colleagues feel about the system?