INFORMATION QUALITY IN NURSING INFORMATION SYSTEMS –EXPERIENCES AND PROBLEMS–

(Completed Paper)

Cathal Ó Riain, Markus Helfert

Dublin City University, Ireland

{coriain | markus.helfert} @computing.dcu.ie

Abstract: Information Quality (IQ) is a problem associated with severe financial and outcome related impacts in the health care sector, and with growing acceptance of evidence-based decision support systems in the industry, it is becoming a key area of both strategic and operational management in the area. However, Nursing Information Systems (NIS) are often under-used and inhibited by poor IQ. This case study examines one such system and identifies a lack of IQ focus in the management of the system under scrutiny. The reasons for the under use of IQ management methods are probed, and problems for nursing management arising from the absence of IQ management processes are outlined. The paper concludes by suggesting principles by which the IQ management perspective could be introduced to meet the information requirements of nurses.

Key Words: Data Quality, Information Quality, Information Products, Nursing Information Systems

INTRODUCTION

The consequences of poor quality data are substantial in the health care sector. Drawing on regional studies carried out in the late nineties, the Institute of Medicine [11] extrapolate that preventable medical errors, caused directly by faulty systems and processes, result in between $17 billion and $29 billion per year in lost income and household productivity, and disability and health care costs. In clinical terms, these errors account for the lives of at least 44,000, and possibly as many as 98,000 people in hospitals in the US each year, and while these figures constitute a very broad range, even the lower estimate exceeds the number of deaths attributable to motor-vehicle wrecks, breast cancer and AIDS each year. These statistics indicate the importance of information quality (IQ) in the health care sector and point towards an urgent need for the development of IQ management (IQM) practices in the area.

It has long been recognized by academics that a high degree of IQ is required for organizations to be best served by information systems (IS) [26]. However, IQM practice has not developed on a significant scale in the health care sector and in the emerging Nursing IS (NIS) domain in particular. A lack of information use by nurses is almost traditional and the reasons cited for this are numerous [21]. Nurses tend to prefer to use intuition rather than hard facts in the course of duty. The information collected by nurses is usually used by other disciplines, and required nursing information is often not of a high quality as a result. Nurses also often lack the understanding of how such information could be used, and are prepared to act on the instructions of others rather than initiating change themselves.

Given this context, this paper examines a typical NIS, and using the case, aims to investigate the reasons for the under use of IQM methods in health care IS. The paper is organized as follows: Section 2 provides an introduction to NIS and nursing workload management, and summarizes recent IQ research in the health care sector. Section 3 describes the background of the study site and research methodology. Section 4 discusses the functionality covered by the NIS under scrutiny in this paper, emphasizing the

importance of IQ in the system and outlines a roadmap to the improvement of the system through established IQM practice. In section 5, we provide an analysis of the reasons for and consequences of the under use of IQM methods. Finally, we summarize our conclusions and outline our plans for further research.

NURSING INFORMATION SYSTEMS AND IQ MANAGEMENT

A general problem with IS terminology is that the same terms are often utilized by different authors for different concepts. Other authors sometimes denote the same concept using different terms. This is particularly true in the health care IS arena. Some researchers see an NIS as a particular type of product that focuses solely on administrative functions, while others view the concept as encompassing both administrative and clinical components, for example. It is therefore important to state the perimeters of our definitions from the outset. We adopt a taxonomy proposed by Hasselbring [10] (figure 1).

This taxonomy builds on earlier classifications medical IS, and views the NIS as any system designed "to support nurses' ability to assist individuals (sick or well) in the performance of those activities contributing to health". Figure 1 also illustrates that NIS have traditionally been designed as isolated systems, which makes integration and organizational information exchange difficult.
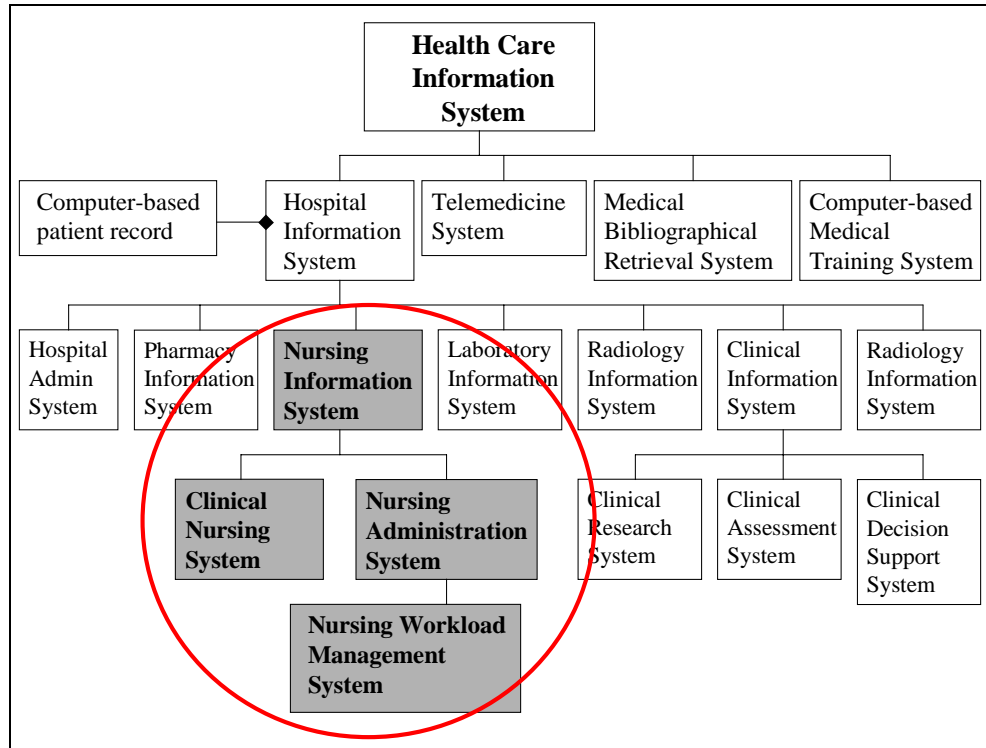

Figure 1: Expansion on Hasselbring's Taxonomy of Health care Information Systems [10]

Using this definition of NIS, the information stored in such a system can be broadly categorized under two headings. Clinical information encompasses all nursing notes made on the process of direct care provision to the patient, while administrative information has a more managerial focus, and is used to enable the effective and cost-efficient management of nursing resources in an organization through such functions as nursing workload management, as is the case with the system under scrutiny in this paper.

Nursing Workload Management

Workload management is a critical subject in the nursing profession. A recent study by Aitken et al. [1] identified higher risk-adjusted 30-day mortality and failure-to-rescue rates among surgical patients in

hospitals with high patient-to-nurse ratios. The same study also confirmed that nurses working in these stressful environments are more likely to experience burnout and job dissatisfaction. In a separate study, Needleman et al. [19] found that a higher proportion of hours of nursing care provided by registered nurses and a greater number of hours of care by registered nurses per day are associated with better care for hospitalized patients. On the financial side, nursing also constitutes a substantial cost element in hospitals today, and the difficulties of defining and measuring quality patient care and nursing productivity, and the probabilistic nature of demand for nursing care all contribute to the complexity embedded in the budgeting process in hospitals [14]. These issues form the core of the requirement for dependency systems such as the Nursing Dependency System (NDS), which record measurements of nursing workloads.

Author	Pub. Type	Domain	Key Results
Lorence, D.P., Jameson, R. [16]	HI	Standardization of IQ assessment methods in health care	Traditional audits are still preferred as the formal means of IQ measurement
Grimson, J., Grimson, W., Hasselbring, W. [9]	IS	Systems integration challenges in health care	There is an urgent need for scalable and generic approaches to sharing quality information in health care
Petersson, H., Gill, H., Ahlfeldt, H. [20]	HI	Standardization of IQ assessment methods in health care	Proposal of a new metric for inter-rater agreement of aggregated diagnostic data
Mikkelson, G., Aasly, J. [18]	HI	Impact of poor IQ in health care	Poor quality data can impair document retrieval in electronic health care records
Aronsky, D. MD, Haug, P.J. MD [2]	HI	Use of data in health care IS in driving complex health care guidelines	Sufficient levels of IQ are pre-requisite to the use of data to support automation of clinical evaluation
Stein, H.D., Nadkarni, P., Erdos, J., Miller, P.L. [22]	HI	Data consistency assessment in a Clinical Data Repository (CDR)	An element of human judgment is required to yield the most accurate information from a CDR
Gissler, M., Shelley, J. [8]	HI	Completeness of data in a health register	IS and question design can improve IQ levels in health registries
Thiru, K., Hassey, A., Sullivan, F. [25]	HI	Standardization of IQ assessment methods in health care	Comparison of study results is difficult without consistent measurement of IQ with clear variables and precisely defined IQ terms
Lorence, D. [15]	HI	Standardization of IQ assessment methods in health care	Agreement is data coding practice is required for sharing quality data to enable the evidence-based health care environment
Gendron, M.S., D'Onofrio, M.J. [7]	IS	Dimensions of IQ in the health care industry	Definition of general IQ dimensions for health care and the need for supplemental domain specific dimensions
Jameson, R., Lorence, D.P., Churchill, R. [12]	IS	Standardization of IQ assessment methods in health care	There is a need to train manager in consistent methods of effective IQ assessment for evidence-based management to evolve
Arts, D.G.T., De Keizer, N.F., Scheffer, G-J. [3]	HI	Improving IQ in medical registries	Development of an IQ assurance framework for medical registries
Lorence, D.P. [17]	IS	Standardization of data reporting in health care	A large degree of patient misreporting exists across the US, leading to adverse clinical and financial impacts

Table 1: IQ research in the health care industry (2000-2005)

IQ Management in NIS

To maximize the quality of nursing management decisions, the considered information must be maintained at an appropriate level of quality. In the case of nursing workload figures, if the effort estimated is below the actual workload, optimal care cannot be provided, leading to the consequences outlined in the paragraph above. If an exaggeration of required resources is reported, money is squandered, placing further pressure on already stressed hospital budgets. In this way, investment in the provision of quality information should be traded off against the costs associated with poor IQ.

In order to address the general problem of ensuring a high level of IQ in the health care sector, a variety of approaches have been adopted by researchers in the past. Table 1 illustrates a summary of recently published related work. The results show that work in this field is generally found in health informatics (HI) rather than IS journals, and tends towards broader industry-wide issues, such as the need for standardization in IQ assessment methods, rather than the more fundamental issue surrounding the lack of promotion of the IQM focus amongst IS managers in the health care setting. We aim to address this gap in the existing literature by examining the reasons for and consequences of a lack of IQM in a typical NIS.

RESEARCH METHOD AND BACKGROUND INFORMATION

Research methods should be aligned to the purpose of the research [13]. The open-ended interviews conducted during this case study reflect the descriptive focus of this papers contribution, aiming to generate understanding for attitudes to IQM in one setting as a pre-cursor to further in depth analysis of the issues surrounding the introduction of IQ methods in the health care sector. Exploratory interviewing took place between October 2004 and June 2005, and in this time we conducted semi-structured interviews with the head of the IS project team that designed the system, the nursing project leader, and nursing IS specialists who act as primary custodians of the NDS. We also engaged in informal discussion with system users. Yin [28] emphasizes the importance of corroborating interview findings with other sources in case study research. With this in mind, a suite of documentation relating to the NDS, including sample reports and help documentation, were obtained to ensure the validity of the work.

Case Background

The hospital under scrutiny in this paper is one of Ireland's largest general hospitals providing acute hospital care services and partaking actively in the country's accident and emergency services. There is currently a bed complement of 620 beds at the facility. A staff of over 2,000 covering approximately 250 disciplines work at the hospital, and an average of 60 patients per day are admitted for trauma or elective treatment, making it one of the busiest general hospitals in Ireland.

Recently published national health strategy in Ireland identifies the requirement for accurate data relating to the administration of the health service, recognizing the need for quality data to enable the effective management of the industry [5]. However, an independent evaluation of the Irish health service found that "it is hard to conceive of an operation of such complexity as health…being managed effectively with the current minimum level of funding in information systems" [4].

It was in this context that nursing staff initiated the in-house development of the NDS under scrutiny in this paper, in order to aid measurement, analysis and management of nursing workload in the hospital. The decision to invest in the system was taken jointly by the hospital IT manager and the director of nursing. Owing to time pressures resulting from under-staffing, most IS projects in the hospital are initiated on the basis of management intuition rather than a rigorously researched business case. This was the case with the decision to develop the NDS.

THE NURSING DEPENDENCY SYSTEM (NDS)

The system was developed by the hospitals IT department in 1999 to replace a disused paper-based system. The NDS sits beneath the Hospital Information System (HIS), which supports many functions within the hospital, although patient care is still supported primarily by paper records within the organization. The general perception of the NDS amongst the user population is positive. The system is easy to use, and therefore does not take from time spent with patients in clinical care, the core responsibility of nurses. NDS source code has been made available to and deployed in other organizations in the Irish health service free of charge. This adds to the perception of the NDS as a success story in the hospital.

Dependency information is comprised of direct workload measurement and indirect non-nursing ward activity tasks such as ward rounds and patient escorts. As a result of the increasingly multi-disciplinary nature of care provision, the system also offers a facility for specialist referrals. Medical specialists can subsequently create an electronic record of care on the system. Other clinical information is also captured in the form of research-validated scoring module for patient pressure sore assessment. However, this case study will focus on the capture of the administrative, workload measurement aspect of the NDS system, the principle purpose for which the system was designed.

Nurses are trained to input the dependency scores of the patients on their wards twice each day, capturing the evolving nursing workload in the hospital. Utilization of the system has been excellent. Only two wards in the hospital do not routinely use the system, as management in these areas retain their own processes for dependency measurement, analysis and management.

The screenshots below (figure 3) outline the various conditions of the patients that are assessed twice daily through the direct workload management module of the system. The NDS accepts these criteria and provides a research validated dependency metric for each patient. Reports have been designed to illustrate dependency levels across wards, units and the hospital as a whole.

Figure 3: Screenshots from the NDS workload management module

Use of NDS Information

A common function of workload management systems is to provide input to the scheduling process. One interviewee explained how dependency figures were used as direct inputs into staff allocation for the following day in other hospitals she had worked in. However, NDS outputs are not used for this purpose, indicating a possible under use of NDS data. Division nurse managers allocate nursing staff based on their own view as they circulate through hospital wards. This suggests that management do not feel confident that NDS information products are suitable for the staffing decisions they need to make.

The sole operational use of the system appears to be that the hospitals director of nursing uses monthly reports provided by the NDS to argue the case for additional nursing resources over periods of time; or at least to defend the position of the hospital in holding on to the resources currently available, as it is accepted that wards will be understaffed against requirements due to under-funding in the Irish health sector. This more strategic deliverable is the only report generated by the nursing informatics team that has been consistently requested by management historically.

Assessing IQ and IQM in the NDS

A common definition states that quality data is 'data that is fit for use' [23]. Data considered appropriate for one use may not however possess sufficient quality for another function [24]. As the following section illustrates, NDS data, although seemingly suitable and valuable to operational resource scheduling, is only utilized for a more long term, strategic purpose, echoing the traditionally isolated view of healthcare systems and their potential uses illustrated in figure 1.

There is no tacit policy in place for the maintenance of IQ on the NDS. It is assumed that the combination of system ease of use and nursing ethics will mitigate to provide quality information. NDS screenshots bear out that the system is user friendly, requiring a simple series of clicks to highlight which of a number of clear options best categorizes the dependency level of a patient. As one interviewee explained, "a patient is either independently up and about or restricted to bed. The options are clear and it is so easy to use that the data on the system must be accurate".

However, a check list to assess the breadth of IQM activities in the hospital, provided in an appendix to this paper, illustrates a lack of IQ focus on the NDS. The assumption that the information on the system is of requisite quality for use, without the systematic use of IQM processes, shows us that IQ awareness in the hospital is not as advanced as it should be. Nurses entering information onto the NDS do not use the information and have no incentive to ensure that their inputs are accurate, contravening one of the key principles of IQM. Given the time pressures associated with nursing at the hospital, it can be assumed that some data input would not be valid due to the need to enter data quickly in order to concentrate on providing patient care. Furthermore, temptation when describing ones workload would naturally tend towards overstatement. Although we have not formally measured the IQ on the system, this evidence, along with division nurse management's reluctance to use NDS data in staffing, indicates that the level of IQ on the system requires some formal management.

Despite the lack of IQM focus in management of the NDS, many IQ categories are satisfied by the system, making it appropriate for strategic use by the hospitals director of nursing. NDS information is readily accessible and represented in a comprehensible format to those who need it (see reports in figures 4 and 5). The NDS provides credible information, usually in a timely manner (monthly reports are sometimes not generated on schedule) that is contextually relevant to the management of nursing in the hospital. The key IQ questions surround the trustworthiness and accuracy of the data on the system, which although suitable, is not utilized for the resource allocation needs of division nursing management. The under use of the information resource provided by the NDS supports the opinion that the quality of the data on the system in not managed convincingly. The information carries the classic hallmarks of a by-product of the NDS system. The software receives more managerial attention than the information on the system. The value of the provided information is not measured. The fact that the system is operating, easy to use and apparently free of bugs means that it is viewed as successful in the hospital and beyond, in spite of the fact that the information is not used as it could be and its quality is unknown. In the following sections, we outline principles for its implementation in the context of the NDS and we examine the reasons for and consequences of the under-use of IQM in the system.

IQ Category	IQ Dimensions	Strategic Use	Operational Use
Accuracy of Data	Believability, Accuracy, Objectivity, Reputation	Suitable	Not suitable
Relevancy of Data	Value-Added, Relevancy, Timeliness, Completeness, Appropriate Amount of Data	Some currency issues	Unknown suitability
Representation of Data	Interpretability, Ease of Understanding, Representational Consistency, Concise Representation	Suitable	Suitable
Accessibility of Data	Accessibility, Access Security	Suitable	Suitable

Table 2: Categories and Dimensions of IQ in the NDS [7]
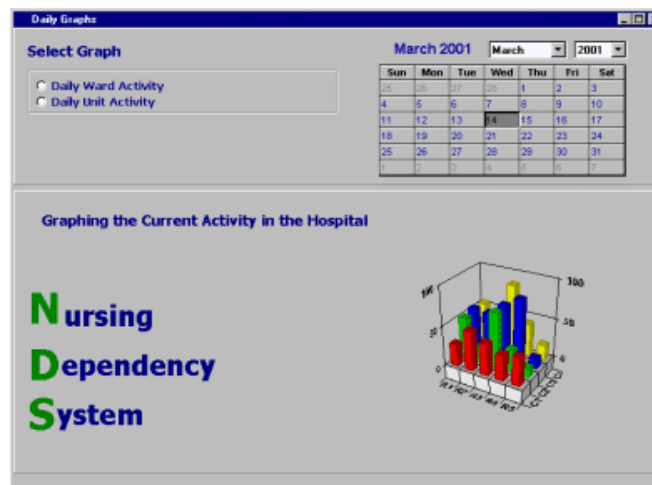
Figure 4: Online daily dependency summary graphic

Figure 5: Paper based dependency report

Principles for the Adoption of IQM on the NDS

In examining the problems encountered by typical organizations, Wang et al. [27] devised an integrated approach to managing information, treating the information supplier (nurses), manufacturer (IS staff) and the consumer (nursing management) of the information collectively as a system. This approach describes four information product management principles, relevant for the future development of the NDS.

Understand Consumers Information Needs

The principle goal of IS should be to deliver quality information to the information consumer. This means the information is viewed as a product, satisfying the attributes to meet or exceed information needs. The consumers of NDS information must be clearly identified. The director of nursing uses monthly dependency reports, but nurse staffing is not influenced by NDS information. The NDS requires too much maintenance effort to justify the limited current use of its data. If the system is to be expanded and utilized for nurse allocation decisions, a requirement will exist to meet the IQ expectations of division nursing managers.

Manage Information as the Product of a Well-defined Production Process

Treating information as a product requires the management of the information process in a similar fashion to the management of the production of a physical product. It must be well defined, contain adequate quality controls and incorporate delivery time management. Once data is entered onto the NDS, no quality control process is in place to ensure its validity. Monthly reports are distributed to nursing management in the hospital, but this process has failed in the past. In addition, the cost of the information production process is not measured. NDS information manufacturing should to be re-examined.

Manage Information as a Product with a Life-cycle

In the case of the physical product, improvement is required over time to ensure that the product remains competitive in the marketplace. If NDS information is to be utilized as an input for the allocation of resources, the needs of the consumers of this information need to be recognized, and better IQM (focusing on information accuracy and believability throughout the life-cycle) will need to be implemented. The required changes result from the changing context in which the information is put to use in the organization.

Appoint an Information Product Manager (IPM)

It is the responsibility of the IPM to manage and coordinate activities between the three main information stakeholder groups, namely the suppliers of raw information (nurses), the manufacturer of the information in the required format (IT staff) and the consumers of the information (director of nursing, division nurse management). IQM practices have not been a traditional focus in the area of health care informatics. A dedicated IPM is needed to manage production of quality information products throughout the hospital.

	Product	By-Product
What is managed?	➢ Information ➢ Information product life cycle	➢ Hardware and software ➢ Systems life cycle
How is it managed?	➢ Integrated, cross functional approach ➢ Encompass information suppliers, manufacturers and consumers	➢ Integrate stovepipe systems ➢ Control of individual components ➢ Cost controls
Why manage it?	➢ Deliver quality information products to consumers	➢ Implement quality hardware and software systems
What is success?	➢ Quality information product continuously delivered over the product life cycle ➢ No garbage-in, garbage-out (GIGO)	➢ The system works ➢ No bugs ➢ Short term perspective
Who manages it?	➢ CIO ➢ Information Product Manager	➢ CIO ➢ IT director and database administrators

Table 3: Information as Product or By-Product [27]

REASONS FOR AND CONSEQUENCES OF THE UNDER USE OF IQM

A key question we aim to address in this paper is to explain why IQM is not given appropriate attention in the NDS and in health care IS in general. In this case, reasons for the lack of focus on the quality of the NDS information are complex and can be broadly categorized between internal and external factors – factors within the direct control of the hospital and external factors, governed by national health care management and advances in technology, over which hospital management have limited or no control.

External Factors	Internal Factors
Lack of empowerment to formulate overall policy	Assumption that quality is adequate
Resources	Lack of information use / recognition of potential future use
Historical lack of IQM focus	Lack of IQM skills and acumen
Lack of national IQ standard	Information value is not measured
Lack of founded IQ reference models	Lack of information consumer focus

Table 4: Reasons for under-valuation of IQM methods

Internal Problems

The most basic internal issues leading to the under valuation of IQM in the NDS relate to the internal view on the quality of data on the system. The assumption that the quality of information is sufficient for its intended use is a dangerous one. It stems from the fact that there is no focus on the needs, or intended use, of the information consumers of the NDS, with the system itself being the centre of attention. The system itself is viewed as the key product in the process rather than the information it manages and provides. The lack of appreciation for the actual final value or use derived from the system data indicates that the assumption that IQ is not an important issue for the NDS could hamstring the future development of the system if the notion goes unchecked. A basic shift in perception of information-as-product rather than by-product is required to resolve these factors.

A second class of internal problem is rooted in the lack of transfer of best practice and concepts to the practitioner setting. The reality in the hospital is that the know-how required to implement IQM methods is not strongly in evidence amongst nursing informatics staff, who come from nursing backgrounds as opposed to IS backgrounds. This leads to a lack of appreciation for the quality of information and its impacts on current and future organizational performance. These problems can also be addressed through staff training and adherence to an IQ assurance framework. However, in this instance, a degree of the onus rests on the academic community to seek channels through which IQ knowledge can be better transferred to real-world settings. The unique environment in which the hospital finds itself poses some additional contextual difficulties to the implementation of IQM, and these factors are discussed below.

External Factors

When considering the potential use of the workload system to influence workload management decisions on nurse staffing, it must be recognized that management hands are tied by budgetary constraints enforced by national health care management. The overall number of nursing staff is dictated from outside the hospital, leading to the question, is there a point in developing an elaborate workload management tool if ultimately, decisions integral to overall workload management rest outside of the organization? Is IQM significant if the information on the NDS itself is not as important as previously assumed? This is something that needs to be investigated before further investment is expended on the NDS. Additionally, the lack of funding available to the hospital means that some of the solutions to internal factors, such as funding for the appointment of an IPM or staff training in IQM methods, is unavailable to the hospital.

In these instances, the hospital is in a difficult position to initiate a change in IQ perception on its own. National health care management have fostered a situation in which IQ is not given the importance it deserves, and though the issue is discussed in the most recently published reform documentation, the hospital will continue to suffer from the institutional view of indifference to IQM until action is taken to implement a national IQ standard on the ground. In this way, many IQ problems in the hospital can be seen to stem from the fact that it is part of a wider organization (the national health care network) that does not appropriately value IQM.

The Future of the NDS

If the use of the NDS is to be expanded to the operational tasks of workload scheduling, two changes are required to the system. The first involves a subtle change of use for the system, to allow nurses to input projected patient dependency levels for the following days work as well as the actual patient dependency on the wards for a given day. But more importantly, IQM practices are required to ensure the quality of the information reported on the system if the management is to trust the data enough to influence staffing decisions. The reasons for the historical under use of IQM must be tackled appropriately. The check list supplied in the appendix to this paper succinctly lists some of the more important IQM tasks to be incorporated into hospital policy. However, at managerial level, a culture change to view NDS information as a product rather than a by-product is fundamental to the future success of the system.

Alternatively, if management recognize the limitation of the information provided by the system, and simply require a tool to report on monthly workloads, then a more appropriate, generic tool should be acquired to fulfill this need. The strategic return on the NDS information alone scarcely meets the investment in time inputting figures and managing the system.

CONCLUSIONS AND FURTHER RESEARCH

This research examined the role of IQM in a typical NIS and the reasons for the under use of IQM in such systems. In this case, under use of IQM results in the limitation of the information managed in the system, culminating in the fact that the optimal value from the investment in the system is not drawn out. Despite the excellent design and reputation of the studied NDS, potentially valuable information resources lie unused, and the quality of the information resource, in the shape of its accuracy and believability, is allowed to atrophy through a lack of IQM focus. The reasons for the lack of IQM focus in the system can be summarized under the heading of internal and external factors.

In the health care sector, hospitals are units in a broader organization, and the question of IQM implementation therefore needs to be viewed contextually. Some perceptions can be changed and actions taken internally to improve the IQ situation in the hospital and system in question in this paper. However, other issues must be addressed at a national level, and this is where national policy makers must take the responsibility to promote IQM in health care IS.

The use of information provided by NIS to empower, transform and innovate the nursing profession has not yet materialized. The impacts of decisions and policies informed by poor IQ in the health care sector are very serious. The time is therefore right for IQ knowledge to be applied to the emergent NIS field. Despite the recognized limitation of generalizing case study results, this study shows clearly that much work is required to transform best practice and academic IQ research into practice in the developing area of nursing informatics. The broader study of poor IQ and the reasons for poor IQM in NIS and its impacts will form the backbone of our future research agenda. In particular, we seek to address the current lack of empirical investigation into the financial and quality of care related impacts of poor IQ on nursing decisions. This study aims to provide tangible evidence of the benefits of IQM to IS managers in the healthcare arena, and will offer insight to aid the future successful implementation of IQM in NIS.

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APPENDIX

A checklist for assessing Information Quality Management activities *(compiled from [6] and experience)*

Activities	
Information is defined as product	No
Knowledge workers are identified as Information customers	No
Knowledge workers specify information requirements, including quality expectations	Yes
Customer satisfaction in the information is the measure of IQ	No
Alignment of strategic information plans with business vision and strategy	No
Model, name and define information consistently among all knowledge workers and information producers	No
Cross-functional enterprise information architecture	No
Automation of information collection where possible	No
Minimize media breaks and intermediary processes	Yes
Single Information capturing	Yes
Complete Information capturing	Yes
Reduction of transformation interface programs	N/A
Measurement of Information Quality	No
Information Quality Management and Improvement processes	No
Information Producer Training	Yes
Access to data definitions and business rules	N/A
Process owners are accountable for information quality (defined in job description)	No
Information producers may be held accountable	No
Definition of Information Quality targets	No
Modeling standards	Partly
Software Engineering standards	Partly
IS architectures standards	Partly
Funding for Application development and re-engineering	No
Adequate training for knowledge workers	No