Data quality maintenance of the Patient Master Index (PMI): a 'snap-shot' of public healthcare facility PMI data quality and linkage activities

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Abstract

Patient (or person) master index (PMI) data quality activities in public, acute healthcare facilities in the state of Victoria, Australia were evaluated in terms of health information management-information technology best practice including data standards and practice guidelines. The findings indicate that, whilst data quality and linkage activities are undertaken, many are limited in scope or effectiveness. In view of published evidence that: (i) duplicate patient files pose significant risks by reducing information available for clinical decision-making; and (ii) quality and clinical risk management require, as a measurable outcome, continuous monitoring of duplicate files, improvements to PMI data quality practices are recommended.

Keywords (MeSH)

Medical Record Linkage; Patient Identification Systems; Medical Records Systems, computerized; Quality assurance, healthcare

Introduction

A research study was undertaken in 2004 to investigate the maintenance of the Patient (or Person) Master Index (PMI) in public sector, acute healthcare facilities in the state of Victoria, Australia.

The Patient Master Index (PMI)

Hospital and non-hospital healthcare facilities use a computerised PMI as a central register or index to identify each patient who has been treated (Huffman 1994; Kuehn & Grzybowski 2001). The PMI is called an index because it links a patient to a unique record number which is used to identify and locate any existing medical records for that patient (South Australian Department of Human Services [DHS] 2002); thus, the PMI minimises within-facility duplication of health and medical records (AHIMA – MPI Taskforce 1997b; Bowman 2002). Positive identification of an individual patient, using data supplied at the time of registration and compared immediately with the data held in the facility's PMI, constitutes an important part of the process of linking the patient with their existing record (Bowman 2002; Standards Australia 2002). The PMI, as a longitudinal index, plays a critical role in supporting continuity of care by facilitating the location of, and access to, health information for individual patients over time (South Australian DHS 2002; Wheatley 2001).

The diversification of health care delivery in recent years has led to significant increases in the number of health care providers and the locations from which patients and clients access care (Teslow & Wilde 2001). This typically leads to the accumulation of patient health information in unrelated data repositories (Hewlett-Packard Development Company 2004; Standards Australia 2002). There is evidence of an increasing awareness of the power of health information derived from both the PMI and patient medical records to support health care delivery and high quality care, and that the value of health information can be greatly enhanced when it is used in conjunction with evolving information and

communication technologies (ICT) such as electronic medical records (Acheson 1971; Briggs 2000; Buck 1971; Hewlett-Packard Development Company 2004; Lewis & Mitchell 1998; Murphy 2001; Rifkin 2001; Victorian DHS 2003; Wager 2002; Wagner 1981).

The enterprise patient master index (EPMI)

The Victorian Department of Human Services (DHS) is attempting to enhance ICT utilisation in the public hospital sector through its *HealthSMART* strategy, the long-term objectives of which include the introduction of a state-wide unique patient identifier, and electronic medical records (Victorian DHS 2003). In recent years, Victorian healthcare networks have begun increasingly to share data and technology resources across facilities, for example via an enterprise-wide patient master index (EPMI) (Toth 1999). An EPMI may either support a single unique record number for each individual patient to be used across all facilities in a network, or be used to maintain a cross-referencing system for all unique record numbers from each facility (Standards Australia 2002).

Sharing of health information, through technology, is also being explored at a national level in Australia, for example via the Commonwealth Department of Health and Ageing's proposed national health information network, Health*Connect* (formerly *HealthOnline*). The aim of Health*Connect* is to facilitate the collection, storage and exchange of patient health information between authorised health care providers and facilities (Australian Government Department of Health and Ageing 2004).

Data linkage and data quality

If PMI data are of poor quality - for instance, if there are duplicates and inconsistencies such as incompleteness in the data format, and if data elements which uniquely identify patients are lacking - the ability to share information across facilities or with internal data repositories such as an 'in-house' pathology system is diminished (Arellano & Weber 1998; Damberg, Kerr & McGlynn 1998). Problems with data quality make the health record linkage process cumbersome, unreliable, and of little value to organisations, providers, and patients (Kerr, McGlynn & Damberg 1998; Standards Australia 2002).

The term 'data quality' refers to characteristics and attributes of the data, specifically: accuracy, accessibility, comprehensiveness, consistency, currency, definition, granularity, precision, relevancy, and timeliness (Teslow & Wilde 2001; Olson, Gallagher, & Fletcher 2001). It has been estimated that a PMI with poor data quality contributes to file duplication rates of approximately three to ten percent (Arellano & Weber 1998): this means that in a PMI containing 500,000 patient files, data for each of 15,000 to 50,000 patients may be in two or more records with different record numbers. It has been suggested elsewhere that duplicate file rates can be as high as 19 percent (AHIMA – MPI Taskforce 1997c).

Aims and objectives

The aims of this study were to create a 'snap-shot' of current practice in data quality and linkage activities, and of the technological capabilities associated with the PMI, and to evaluate these in the context of facility size and health information management (HIM)/information technology (IT) best practice.

The objectives of the research were:

- to identify the scope of responsibility for the PMI in Victorian public, acute healthcare facilities
- to elicit estimated sizes of PMIs, quantified by the number of patient files
- to investigate staff access to the PMI, and related training practices and procedural documentation for patient registration and associated PMI search strategies
- to examine how the capabilities of available technology are utilised in PMI management, particularly whether the technology assists in identifying duplicate patient files
- to ascertain the scope of attempted activities aimed at improving PMI data quality and, where such activities are not undertaken, to identify reasons why they are not
- to establish the extent of intra- and inter-facility PMI data linkage, estimate how successful data linkage activities are and identify factors that frustrate PMI data linkage attempts

- to provide suggestions, based on the study's results, for PMI data quality management and maintenance improvements in Victorian public healthcare facilities.

Underlying assumptions

For the purpose of the research, it was assumed that:

- All Victorian public, acute healthcare facilities maintain a PMI as a central data register of all patients who have accessed their services.
- These facilities use their PMI to index individual patients to a unique record number which, in turn, facilitates locating each patient's medical record.
- The PMI is the logical central data repository from which linkage would or does occur (Abdelhak 2001; Huffman 1994).
- HIM professionals, who typically maintain the PMI, have the knowledge and skills to audit the accuracy and completeness of patient-identifiable data and health information, and to conduct routine data quality monitoring (Teslow & Wilde 2001; HIMAA- Education Committee 2001).[1]

The literature

There is a wealth of literature emanating from the United States of America, Canada, New Zealand, the United Kingdom, and various Australian states, particularly South Australia, describing PMI data quality and record linkage techniques and their importance (Acheson 1971; AHIMA - e-HIM Taskforce 2003; AHIMA - MPI Taskforce 2004; AHIMA - MPI Taskforce 1997a, 1997b, 1997c; Arellano & Weber 1998; Carine & Parrent 1999; Drake & van Gemert 2003; Hewitt & O'Connor 2002; Holman et al. 1999; Lenson 1998; Manitoba Center for Health Policy 2003; McAlpin 2003; New Zealand Health Information Service 2003; Roos et al.1996; South Australian DHS 2000, 2002; Taylor 2003; Toth 1999; Wagner 1981; Walker 1999; Wheatley 2001). The American Health Information Management Association (AHIMA) Master Patient Index task force describes a PMI that has a notable standard of data quality as being one of the most important resources in a health care organisation because 'it is the link tracking patient, person or member activity within an organization and across patient care settings' (1997a: para.1). AHIMA (1997a) also recommends that responsibility for PMI maintenance should be centralised under the direction of Health Information Management (HIM) professionals.

Guidelines and standards

Australian Standard AS 5017-2002

This standard provides 'a framework for improving the confidence of health service providers and clients alike that the data being associated with any given individual, and upon which clinical decisions are made, is appropriately associated' (Standards Australia 2002: p. 5). According to Standards Australia, the ability to identify an individual, find their unique record number, and locate their medical record is 'critical to the provision of speedy, safe, high quality, comprehensive and efficient health care' (2002: p. 5).

National Health Data Dictionary (NHDD)

The NHDD contains health data definitions and has been designed to improve the comparability of data across the healthcare industry (AIHW 2004).

Many state-specific data standards, such those produced by the South Australian DHS, have been informed by AS 5017-2002 and the NHDD; both are voluntary codes of practice and the extent to which they are utilised by healthcare facilities is unknown.

Risk management

Healthcare facilities must have the capability to locate accurately the medical record of an individual patient, in order to provide clinicians with the history and other information to inform safe, knowledge-based decisions. Healthcare providers often have to undertake the burdensome task of requesting medical records from other providers to gain a somewhat fragmented medical history of their patients (Goldman & Tossell 2004). Wilson and Goldschmidt (1995: 509) stress that a patient's medical record "…is the core of the totality of

1 In order to be accredited by the peak professional body, the Health Information Management Association of Australia (HIMAA), HIM curricula in Australian universities must comply with core, profession entry-level competencies. For example, within 'Domain H: Health information system concepts and processes', competency elements require that HIM graduates have the ability to undertake health information and data auditing and quality activities (HIMAA 2001).

information relevant to patient care…", that it is paramount in assisting health professionals make clinical decisions and that its accuracy and timeliness are the linchpins of serious risk avoidance. HIM professionals, in designing and managing the information systems that hold these vital records, must ensure that the PMI meets their facility's obligations in clinical risk management (Callahan-Dennis 2001).

Accreditation

Victorian acute healthcare facilities are required to meet the accreditation requirements of the Australian Council on Healthcare Standards (ACHS), the International Organization for Standardization's Quality Management System (ISO 9002), or the Quality Improvement Council's Health and Community Services Standards (QIC), all of which promote the importance of quality management and improvement of information to support the functions of the healthcare facility (Victorian DHS 2004).

The ACHS EQuIP guide requires that facilities apply infrastructure standards to the main organisational functions in order to support the delivery of high quality, safe care. The standards most relevant to PMIs relate to 'Information Management' (Treacy 2003). The EQuIP guide describes the importance of information management, thus:

> … The provision of quality care and the effective and efficient management of health care organisations are dependent on timely and accurate information. Organisations need to continuously improve their management of data and information, especially with respect to the creation of information from data, how information is used across the organisation, and whether information is available when needed (ACHS 2002: 87, section 4).

Gaps in the knowledge

Other than accreditation requirements, and statutory requirements surrounding mandated data collections (for example, the Victorian Admitted Episode Dataset [VAED]), there is little published evidence of the application of uniform data standards in Victorian hospitals. Furthermore, there is scant information available on the data quality of PMIs in these facilities, the techniques and rationale applied to data quality maintenance, or whether there is intra-facility consistency in practice.

PMI search algorithms

There are three types of automatic patient matching (Gudea 2005); all three use a combination of patient-identifying data elements within an algorithm to determine whether two separate files belong to one individual patient or client. These processes are usually unseen by the end-user:

- *Deterministic algorithm ('exact match')*[2]*:* This performs an exact match based on a specific combination of data elements.
- *Rule-based algorithm ('fuzzy logic')*[3]*:* This assigns weights to patient data elements. The weights are used to compare patient files for matching.
- *Probabilistic algorithm*[4]*:* Formulae are used to analyse the PMI data to determine match weight probabilities for each data element.

The use of a unique patient identifier in all PMIs and EMPIs is suggested by AHIMA (1997b) to facilitate linkage activities and to match patients accurately with their existing medical record; in regards to patient record linkage methodologies, AHIMA explains that the majority of healthcare facility patient information systems use deterministic algorithms which often result in false matches. The Association considers probabilistic matching to be the most sophisticated technique available (AHIMA 2004) and that issues such as decentralised patient registration and a lack of data standards have a negative impact on PMI data quality and record linkage methodologies.

PMI linkage studies

Gudea (2005) states that because probabilistic matching has an accuracy rate of 90% or higher, it offers the greatest potential to maintain PMI integrity. This appears to be reflected in the choices of several high profile health data linkage projects such as the Oxford Record Linkage Study (ORLS) in 1963-1999 (Acheson 1971; Gill 1997); the Western Australian Linked Database Project,

2 For example, a file containing First Name: Mary. Surname: Brown. Sex: F. DOB: 22/07/2004, would be determined an exact match with a file containing First Name: Mary. Surname: Brown. Sex: F. DOB: 22/07/2004.

3 For example, as a routinely collected and relatively reliable data element, DOB may be assigned a high match weight compared to middle name, which may be assigned a lower match weight.

4 For example, in a PMI where the Surname: Smith appears much more frequently than the Surname: Williams, a match on Smith will have less import than a match on Williams.

which commenced in 1980 and was the first of its kind in Australia (Holman et al. 1999); the New Zealand Health Information Service (NZHIS) national, demographic register of all healthcare facility patients, which commenced in 1992 and covers approximately 98% of the population (NZHIS 2003); and the South Australian data standardisation initiatives and Oacis Programme, developed by that state's Department of Human Services (DHS) (South Australian DHS 2000; 2002; 2003). The aims of the latter program include patient record linkage and a fully functional clinical information system across Adelaide's eight metropolitan, public healthcare facilities. Its success relies heavily upon the input of high quality patient data into the EMPI, where linkage of records occurs. Drake and van Gemert comment that '… incorrect linking… of individual client records could have a significant risk management impact on service provision and hamper the system's ability to deliver a seamless service' (2003: para 5). It is in the interests of the Oacis Programme team to assist facilities with their data entry practices, to ensure that there is a common understanding and standardised practice in the collection, storage and transmission of patient data. A working party consisting primarily of Health Information Managers (HIMs) and representing the participating facilities created a series of publications on medical record documentation and data capture standards, and client identification standards for PMIs, with which all facilities are expected to comply (South Australian DHS 2000; 2002; 2003). Issues addressed included patient search principles, PMI training requirements, and minimum requirements for PMI data elements.

Quality maintenance activities

Data capture features are an important component of the PMI to support data quality at the point of data entry (Wilde & Teslow 2001). The AHIMA suggests that a comprehensive PMI maintenance program should include ongoing processes to identify and address existing data errors, and that HIMs should ensure that PMI policies and procedures are regularly reviewed and updated (AHIMA – MPI Taskforce 2004). Perry (1996) found a decade ago that Victorian HIMs supported the use of performance measures, including for PMI maintenance. The AHIMA practice briefs further advise the need for an adequate staffing complement, relative to PMI size, to maintain and ensure data quality (AHIMA – MPI Taskforce 2004).

Quality maintenance activities associated with the capacity to capture and share patient information include:

- implementation and maintenance of PMI data standards and unique patient identification standards.
- teaching persons who register patients on the PMI about data standards and patient search and registration techniques
- identification and rectification of duplicate patient records. This is known as record linkage (Standards Australia 2002).

Method

Sample selection

At the time of the study there were 122 public, acute healthcare facilities in Victoria. A publicly available data file from DHS included the number of acute care separations (inpatient discharges) from these facilities for the most recent financial year (2002-2003). A decision was made to include in the study only those facilities with a minimum activity level of 2,000 acute care separations per annum. This criterion was established to protect the validity of responses, and was based on the researchers' prior knowledge that smaller inpatient facilities were likely to have neither the technology resources nor the staffing complement with appropriate knowledge and qualifications to complete the technical items in the questionnaire.

Sixty facilities (49.2% of the 122) met the inclusion criterion and made up the target population. These facilities were categorised according to the number of acute care separations in the 2002 - 2003 financial year: ≥2,000 but <12,000 'small' facilities (n = 29; 48.3% of the 60); ≥12,000 but <24,000 'medium' facilities (n = 12; 20.0% of the 60); and ≥24,000 'large' facilities (n = 19; 31.7% of the 60).

The categorisation into small, medium and large was based on the assumption that different-sized facilities potentially undertake different PMI data quality and linkage activities. This could be

due to: (i) the number of files and the proportion of PMI duplicates; and (ii) the available staffing and technological resources.

Approval for the research was granted by the La Trobe University Faculty of Health Sciences Human Ethics Committee.

Advance notice of the research survey was provided via the 'University News' column of Dataline, the newsletter of the Health Information Management Association of Australia (Victorian Branch): one of the researchers (KR) advised members that a PMI survey was to be conducted and that public healthcare facility HIMs might expect to receive a questionnaire in the mail in the coming months.

Study design

A cross-sectional survey was conducted during August, 2004 using a self-administered questionnaire. The questionnaire was mailed, with an introductory letter and reply-paid envelope, to the person responsible for the management and maintenance of the PMI in each of the 60 facilities targeted for the study. The timeframe for completion of the questionnaire was 14 days. The numbered questionnaire preserved respondent anonymity for results reporting but enabled telephone follow-up of non-respondents after two weeks; a one-week extension was granted where necessary.

The survey instrument

The self-administered questionnaire designed for this non-experimental research study included 22 items: ten closed questions; five open, narrative-type questions seeking opinions; and five mainly closed questions with provision for explanation or details. The penultimate question was open-ended and invited further comments; the final item was administrative and related to the notification of results.

Part 1 of the questionnaire (five questions) was designed to elicit details of the respondent's position in the organisation and the size of their PMI; these questions related to the first two research objectives (scope of responsibility for the PMI; and PMI size, quantified by the number of patient files). Part 2 comprised five questions designed to elicit information to meet the third research objective and related to data quality management of the PMI through staff training and resources. Part 3 comprised eight questions, relating to the fourth and fifth research objectives, about data quality management of the PMI involving duplicate patient files. Part 4 comprised three questions, relating to the sixth research objective, designed to derive information on respondents' activities at attempted PMI linkage with other internal systems and/or other healthcare facilities. The remainder of the questionnaire constituted the final two questions. The seventh research objective was achieved through analysis of the responses to all questions, including the penultimate (open, comment) question.

The questionnaire was amended prior to use to reflect the outcomes of a two-phase pilot trial.

Data analysis

The analysis of the responses was based upon a concurrent nested design; specifically, whilst the data were analysed via a predominantly quantitative approach, the analysis also included an embedded qualitative strand to assist in validation of the results. The responses to the closed items were coded, and computations calculated and displayed using Microsoft Excel. Responses to the open-ended questions were transcribed into Microsoft Excel for reference purposes. Anonymity of participants and facilities was preserved throughout.

Results

Response rate and study sample

A representative from each of 51 of the 60 eligible facilities responded, giving a response rate of 85%. These 51 respondent facilities formed the study population. The terms 'respondent' and 'respondent facility' have the same meaning in this study. The response rate was >80% in each of the small, medium, and large facility categories. Of the 51 respondent facilities, 25 (49%) were small, 10 (19.6%) were medium-sized, and 16 (31.4%) were large.

Responsibility for the PMI

All 51 respondents indicated that, as part of their position, they held responsibility for the maintenance and management of the PMI; 31 respondents (60.8%) shared this responsibility with another person. In all, 47 (92.1%) of those

with responsibility for the PMI were HIM professionals. Health Information Managers held this responsibility in all of the large facilities; only one information technology professional/system support person had this responsibility in a medium-size facility; and administrative staff had responsibility in three of the small facilities.

PMI size

Each respondent estimated the number of patient files contained in their respective facility's PMI (Table 1). Some respondents may have been able to provide an accurate figure through query of their PMI system; however, there was no provision in the questionnaire to accommodate for differentiation between actual and estimated figures. Thirty-five respondent facilities (68.6%) had PMIs containing less than 500,000 patient files.

Table 1: PMI size estimates, per facility size category and overall

NO. OF PATIENT FILES CONTAINED ON THE PMI *	SMALL FACILITY	MEDIUM FACILITY	LARGE FACILITY	TOTAL	%
<100,000	16	2	0	18	35.3
≥100,000 and ≤499,999	7	6	4	17	33.3
≥500,000 and ≤999,999	2	1	6	9	17.7
≥1,000,000	0	1	6	7	13.7
Total	**25**	**10**	**16**	**51**	**100.0**

* Based on an estimate provided by respondents

PMI training practices and procedural documentation

The respondents in the 51 facilities were asked to give an estimate of the number of staff members in their facility who could use the PMI (register patients and update patient details). In 33 facilities, the estimate was 1–<50 staff, in nine facilities it was 50–<100 staff, and in five facilities 100 or more could use the PMI. Respondents in four large facilities failed to give an estimate and did not explain why they did not. Respondents who did give an estimate generally intimated difficulty in doing so due to the decentralised use of the PMI throughout various departments and because staff use of the PMI was not within the respondents' control.

Training new staff

Table 2 shows that only six facilities (11.7%) provide all new staff, facility-wide, with a standardised PMI training program including training in registering patients and updating patient details on the PMI. It is seen that in 33 facilities (64.8%) there is no standard PMI training program.

Table 2: PMI training practices for new staff, by facility size, and overall

DESCRIPTIONS OF PMI TRAINING PRACTICES FOR NEW STAFF	SMALL FACILITY	MEDIUM FACILITY	LARGE FACILITY	TOTAL	%
A standard, facility-wide training program is provided for all new staff	2	2	2	6	11.7
A standard, facility-wide training program is provided for certain categories of new staff	6	0	6	12	23.5
All new staff receive training, but there is *no standard training program* – training is decentralised	9	6	4	19	37.3
Certain categories of staff receive training, but there is *no standard training program*	8	2	4	14	27.5
Total	**25**	**10**	**16**	**51**	**100.0**

Documentation of PMI search and registration procedures

Forty-six (90.2%) of the respondent facilities have a PMI procedure manual. Nineteen of the 46 (41.3%) had updated or reviewed their procedure manual during the year of the study (2004). A further 15 facilities had updated their manual in the previous year (2003); four had updated two years ago (2002); one facility, three years ago (2001); and two facilities, four years ago or more (2000 and prior). Five facilities did not respond regarding the manual update.

Capabilities of available PMI management technology

The subjects identified, from the following list, the data capture features of their PMI software that support data quality at the point of data entry:

- 'Use of mandatory data fields to promote data capture, e.g. Surname, Given name, Data of birth and Sex must be recorded for any new registration'
- 'Data edits on specific fields, e.g. Data of birth cannot be greater than current date'
- 'Use of drop-down menus (or similar) for accurate data entry choices, e.g .Lists for Suburb, Country of birth, …
- 'Other (features)'.

Approximately 73% of the respondent facilities reported using PMI software with three or more data capture features that support data quality at the point of data entry. Five facilities (9.8% of respondents) had one data capture feature; nine (17.7%) had two features; 33 (64.7%) had three; and four (7.8%) used at least four data capture features. Comments by some who nominated 'Other' included: '[Our PMI software offers] edits on a number creation to avoid inadvertent inclusion of characters' and '[Our PMI software offers] warning messages on missing data fields and other data entry errors'.

Responses concerning the frequency of purposeful, routine data quality activities aimed at locating duplicate patient files in the PMI are summarised in Table 3.

Table 3: Frequency of routine data quality activities aimed at locating duplicate patient files, by facility size

FREQUENCY	SMALL FACILITY	MEDIUM FACILITY	LARGE FACILITY	TOTAL	%
Daily	2	0	4	6	11.8
Weekly	0	1	1	2	3.9
Monthly	5	4	3	12	23.5
Half-yearly	3	0	0	3	5.9
Yearly	6	1	0	7	13.7
Ad hoc or Never	9	4	8	21	41.2
Total	**25**	**10**	**16**	**51**	**100.0**

Further analysis undertaken to establish whether the size (number of files) of the PMI, as distinct from the size of the facility, correlates with the frequency of searching for duplicate records showed that facilities with larger-sized PMIs (those comprising 500,000 files and more) undertake more frequent daily data quality activities, as opposed to monthly or yearly activities, than do facilities with relatively small PMIs (<500,000 files). The latter facilities tend to undertake PMI data quality activities at more infrequent intervals, for example monthly and yearly, and have a higher incidence of undertaking PMI data quality activities on an 'Ad hoc' basis, or 'Never' (where ad hoc refers to non-routine activities undertaken to locate duplicate files on an 'as needs' basis).

Methods of identifying duplicate files

Eight of the 51 respondent facilities used more than one method to monitor duplicate patient files in their PMI. Table 4 shows that most facilities 'utilise a report generated by the PMI software' to monitor duplicates. Only minorities of facilities use any of the other methods listed in Table 4.

Table 4: Methods of monitoring duplicate patient files on PMIs per facility size, and overall

METHODS OF MONITORING DUPLICATE PATIENT FILES	SMALL FACILITY	MEDIUM FACILITY	LARGE FACILITY	TOTAL (METHODS USED)
Utilise a report generated by the PMI software	20	6	10	36
Utilise a report generated by an internal report writer	2	2	3	7
Utilise a manual register of duplicates that is maintained by clerical or other staff	1	3	4	8
No monitoring undertaken, or PMI incapable of running any sort of duplicate report *	3	0	1	4
Other methods	2	0	3	5
Total	**28**	**11**	**21**	**60**

Note: Respondents were able to select more than one option.

*This group of respondents generally indicated that their PMI system was incapable of running any sort of duplicate report.

Some of the respondents who did not monitor or who used other methods explained their selections thus:

- 'Pathology (uses a different computer system with an interface to the main system) sends regular lists of duplicate numbers that they have detected'
- 'Identified on a case by case basis when searching for a patient, that's when we note if they have more than one UR number'
- '[We] also utilise benchmark duplicate KPI's [key performance indicators] across the network'.

Duplicate files (per month)

The respondents' estimates of the monthly number of duplicate patient files found in their PMI are shown in Table 5. They have been grouped for the purposes of data analysis. Nine facilities did not respond to this question. Four very 'small' facilities reported zero duplicates per month; it is noted that had the question asked for annual duplicates, a different response might have been received from these very low-activity facilities. Of the remaining 17 small facilities that responded, the range of monthly duplicates was 1-19, with a mean of 7.7 duplicates per month. When all the responses of small facilities are collapsed, the 21 respondents had a mean of 6.2 duplicates per month.

Ten medium size facilities responded and their range of duplicates was 1-30, per month, with a mean of 14 duplicates per month. Twelve of the 'large' facilities responded; the range across these facilities was 15-200, the upper and the mean was 51 duplicates per month. The upper level of the range (200 duplicates) was an outlier, as the next highest was 75 duplicates; when this outlier was excluded, the mean for the other large facilities was 38 duplicates per month.

Table 5: The estimated number and percentage of duplicate patient files found in PMIs

NUMBER OF DUPLICATE PATIENT FILES, PER MONTH	SMALL FACILITY	MEDIUM FACILITY	LARGE FACILITY	TOTAL	PERCENTAGE (OF THE 42 RESPONDENTS)*	CUMULATIVE PERCENTAGE (OF THE 42 RESPONDENTS) *
0 duplicates	4	0	0	4	9.5	9.5
1 to 9	12	3	0	15	35.7	45.2
10 to 19	3	4	2	9	21.4	66.6
20 to 29	1	2	1	4	9.5	76.1
30 to 39	0	1	3	4	9.5	85.6
40 to 49	1	0	1	2	4.8	90.4
50 to 99	0	0	3	3	7.1	97.6
≥ 100	0	0	1	1	2.4	100.0
Total	**21**	**10**	**11**	**42***	**100.0**	**100.0**

* 42 of the 51 respondents answered this question

Of the nine (17.6%) respondents who did not answer the question about the monthly number of duplicate files found, some provided comments instead and indicated difficulty in estimating a monthly rate of duplicate files because they use a duplicate patient file report on an ad-hoc (occasional; as needs) basis. One respondent from a large facility wrote '[duplicates occur in] 3.2% of patient registrations – based on an audit conducted in August 2003' (nine months prior to this survey).

Automatic matching

Twenty-four (47%) of the respondent facilities had PMI software with the capability to match automatically, while 20 of the 24 actually utilise that capability. Just over half of the respondent facilities (n = 27, 52.9%) indicated either that their PMI software does not have the capability to match patient files automatically, or that they were not sure if it had this capability.

Fifty-eight percent of the respondent facilities use a deterministic algorithm, 17% use a rule-based algorithm, and 25% of respondents were not sure or did not know the type of matching algorithm used. The most sophisticated type of algorithm, 'Probabilistic matching', was not selected by any respondents.

Attempted PMI data quality improvement activities

Respondents were asked to identify the number and type of activities undertaken to improve PMI data quality and, where applicable, to identify reasons why such activities had not been undertaken. The most commonly selected data quality activity was 'Purposeful search, identification and correction of duplicate patient files' (n = 15): see Table 6.

Table 6: Activities undertaken in the past two years to improve PMI data quality, by hospital size

ACTIVITIES UNDERTAKEN IN PAST TWO YEARS TO IMPROVE PMI DATA QUALITY	SMALL FACILITY	MEDIUM FACILITY	LARGE FACILITY	TOTAL OF THESE IMPROVEMENT ACTIVITIES
Purposeful search, identification and correction of duplicate patient files	7	4	4	4
Implementation of new data capture tools, eg edits, mandatory fields	4	0	2	2
Implementation of new search and registration processes	2	1	3	3
Working towards implementation of Australian Standard Health Care Client Identification AS-5017	3	1	5	5
Purposeful search and correction of missing and erroneous data items	2	1	2	2
Facility-wide training of PMI users of patient search and registration practice	1	0	0	0
No response	6	2	0	0

Respondents nominated factors why no, or fewer than was desirable, PMI data quality improvement activities were undertaken in their facility.

Table 7 shows that the most common reason was lack of staffing resources, followed by lack of IT resources. Most respondents (n = 30 or 58.8% of the respondents) indicated that their facility was not prevented them from undertaking any, or further, PMI data quality improvement activities.

Table 7: Factors preventing PMI data quality improvement activities from being undertaken, by facility size

REASON *	SMALL FACILITY	MEDIUM FACILITY	LARGE FACILITY	NUMBER AND PERCENTAGE OF RESPONDENT FACILITIES CHOOSING THIS OPTION	
				NO.	%
Lack of staffing resources	5	5	7	17	33.3
Lack of IT resources and/or capabilities	5	1	4	10	19.6
The facility (governing body) does not perceive any benefits from improving PMI data quality*	0	0	0	0	–
Activities were completed just prior to the defined two-year period	0	2	0	2	3.9
No problems have been identified with the data quality of the PMI	1	0	0	1	2.0
Not applicable / Not that I'm aware of	16	5	9	30	58.8
Other reasons not listed	1	0	1	2	3.9
Total	28	13	21		

* Note: Respondents could tick as many reasons as applicable to them

All PMI data quality aspects

The following is a selection of respondents' comments on all data quality aspects of the PMI, including duplicate files:

- '[We are] waiting for a PAS (Patient administration system) replacement, as our older registration system doesn't support good work practices which would improve data quality'
- 'We routinely take errors in registrations back to the staff concerned so that they are aware of the consequences and clinical risks associated...'
- '[We are] technically unable to regularly run the potential duplicate report in-house.' '[We] do not have the clerical resources to merge all the records of duplicate unit record numbers.'

Intra- and inter-facility PMI data linkage and successes

An objective of the researchers was to gain insight to the intra- and inter-facility PMI data linkage practices and their success in terms of the resulting data quality. Table 8 shows the number of facilities that attempted each of the five data linkage activities. There were 82 attempts over the 51 facilities. Respondents rated their successes on a 5-point scale ranging from 'Very successful' to 'Very unsuccessful'. Most attempted PMI linkage activities have occurred with intra-facility systems (n = 34) such as a pathology system. Eighty-two percent of the 51 facilities in the sample have attempted some PMI data linkage activities. Most attempts (81.7%) at data linkage were successful in terms of data quality.

Problems affecting PMI data linkage activities

Respondents were invited to select as many options as were applicable when indicating the greatest difficulty to overcome in PMI data linkage activities; see Table 9. The most common responses were:

- '[There is] a lack of information technology resources to support a linkage activity' (n = 27, 53.0% of facilities); this was particularly a challenge for small facilities; and
- '[There is] a lack of staffing resources to support a data linkage activity' (n = 20, 39.0% of facilities).

Additional reasons were provided by the following respondents.

Three large facility respondents:

- 'PMI details are not updated at each episode.'
- 'Limitations in PAS software require whole of surname search.'
- 'Many unknown patients in the triage system in ED issued a new UR number, then cannot be merged while the inpatient episode is active.'

Two medium size facility respondents.

- 'Poor data entry by staff in other areas.'

Table 8: Success rating of attempted PMI linkage activities

PMI DATA LINKAGE ACTIVITY	NUMBER OF ATTEMPTS	RATINGS OF SUCCESS, IN TERMS OF DATA QUALITY, OF THE ATTEMPTS ACROSS THE FACILITIES				
		VERY SUCCESSFUL	SUCCESSFUL	MEDIOCRE	UNSUCCESSFUL	VERY UNSUCCESSFUL
To a system within your facility	34	11 (32.4%)	16 (47.1%)	6 (17.6%)	1 (2.9%)	0
To a data repository within your facility	21	6 (28.6%)	12 (57.1%)	3 (14.3%)	0	0
To a separate PMI within your facility	12	2 (16.6%)	8 (66.6%)	2 (16.7%)	0	0
To a PMI from a different facility within your network	7	3 (42.9%)	3 (42.9%)	1 (14.2%)	0	0
To a PMI from a different facility within your alliance	5	0	4 (80.0%)	1 (20.0%)	0	0
Other	3	1 (33.3%)	1 (33.3%)	1 (33.3%)	0	0
Total	**82**	**23 (28.0%)**	**44 (53.7%)**	**14 (17.1%)**	**1 (1.2%)**	**0**

Table 9:The greatest challenges, in terms of PMI quality, in a PMI data linkage activity

THE GREATEST CHALLENGES, IN TERMS OF DATA QUALITY, IN A PMI DATA LINKAGE ACTIVITY	SMALL FACILITY	MEDIUM FACILITY	LARGE FACILITY
An excessive amount of duplicates existing in the PMI prior to linkage activity	5	4	9
A poor matching algorithm is used	5	1	5
Incomplete and erroneous data in the PMI which would prevent probable linkages	4	2	8
Differences in application of data standards from one PMI to the next	7	3	4
A lack of information technology resources to support a linkage activity	17	5	6
A lack of staffing resources to support a linkage activity	8	3	9
Other	3 *	2 *	2 *
Total (challenges faced)	**49**	**20**	**43**

* These respondents provided other reasons.

- 'Merge of the PMI resulted in many duplicates that are being systematically removed as clients present.'

Three small facility respondents.

- 'There is always the potential for errors and breakdown to occur.'
- 'Such an undertaking and not appreciated by management who dictate the above items (Pathology systems, data repository, etcetera). Subject to the decisions made by an IT alliance at a regional level. Generally, agreement is not easily obtained.'
- 'Lack of recognition in various areas, of the need for accurate, complete data rather than rudimentary completion of fields.'

General comments

The following represent a cross-section of the comments on current and proposed future data linkage activities and feedback to the researchers, provided in the final open-ended question:

- 'Our experience … has shown that merging PMIs has enormous workload implications. A great deal of planning needs to go into this.'
- 'I have been surprised that many HIMs do not actively merge duplicates or look for them, and have let this process slide as they do not see it as "core business". When staff resources are scarce this is the first thing that gets dropped. I see that in fact it should be a very important role of an HIS [department] as the problems that duplicates create is enormous both in clinical risk and the resources consumed.'

- '[We are] consistently endeavouring to improve the quality of data on the PMI. Standardisation on information on the PMI is becoming more important as data is used for other modes of communication, eg. SMS or email, outpatient appointment reminders.'
- 'It is envisaged that we will develop a common health record over several campuses. Our computerised PMI will be the basis and essential tool with this merge. Should this occur, increased training and development would be required. We also utilise the computerised PMI for reference to destroyed, deceased and stored files.'

A number of respondents commented on the need for a state-wide, public hospital sector, unique patient identifier to facilitate PMI record linkage activities. In this context, several mentioned the Victorian Department of Human Services' HealthSMART strategy as potentially offering the opportunity to address this issue.

Discussion

HIM role: technical and managerial

Almost all (92%) of those responsible for the PMI are HIM professionals. This statistic is consistent with the published literature; for example, AHIMA (1997a) recommends that responsibility for PMI maintenance should be centralised under the direction of HIM professionals, and that other healthcare facility employees responsible for PMI maintenance should be carefully trained and supported by appropriate documentation tools. Given the content of the HIMAA core competencies supporting University curricula for entry-level graduates, HIMs are well-positioned to understand the importance of the PMI and related data quality activities (HIMAA 2001).

There is not such consistency in relation to training of staff. It is noted that despite the overall responsibility by HIMs for the PMI, the majority of hospitals surveyed in this study reported PMI training practices that are decentralised, and there is not a standard PMI training tool for all staff in Victorian public hospitals. In the majority of the facilities surveyed, fewer than 50 staff members in each facility have the requisite capabilities for registering and updating patient details on the PMI. Therefore, HIMs appear to have responsibility for the PMI, but not for training staff who use it in a decentralised environment. This finding is also of interest in light of the AHIMA (1997a) recommendation that patient registration practices should remain centralised to ensure data quality.

A majority of facilities surveyed have PMI procedure manuals available to support users; this is consistent with recommendations of the AHIMA Taskforce (AHIMA – MPI Taskforce 2004). However, there is some room for improvement in the level of currency as approximately less than half had been updated or reviewed within the past year.

Automatic matching

Whilst 20 respondent facilities have, and use, PMI software with the capability to match patient files automatically, none indicated that the type of matching used was probabilistic. This contrasts with reported PMI features elsewhere (for example, see Acheson 1971; Gill 1997; Holman, Bass, Rouse & Hobbs 1999; New Zealand Health Information Service 2003; South Australian DHS 2000; 2002; 2003). However, the results in this study were consistent with the use of a deterministic 'exact match' algorithm. It is noteworthy that, whilst the AHIMA (1997b) states that probabilistic matching is far preferable (AHIMA 2004), the majority of healthcare facility patient information systems in the United States of America use deterministic algorithms which often result in false matches (AHIMA 2004).

PMI data quality improvement activities

The findings indicate that many Victorian public hospitals do not perform purposeful, routine data quality activities aimed at locating patient files; however it would appear that a considerable number of facilities do have PMI software with the capability to produce a report that identifies potential duplicates. Most of the facilities in the current study had undertaken only one activity aimed at improving PMI data quality within the previous two years. This suggests that data quality activities are not conducted as on-going or continuous processes. The fact that a lack of staffing and IT resources, were nominated by 33% and 18.6% of the respondents, respectively, as presenting barriers to undertaking PMI data

linkage activities is informative in identifying a need for future improvements. It is noted that the AHIMA practice briefs advise the need for an adequate staffing complement, relative to PMI size, to maintain and ensure data quality (AHIMA – MPI Taskforce 2004).

Trends in intra- and inter-facility PMI data linkage

Eighty-two attempted data linkage activities were reported, mostly internal to the individual facility. This finding supports the comments found in much of the reviewed literature that sharing health information internally across systems, and externally to the systems of other facilities, is becoming commonplace in the healthcare industry (Arellano & Weber 1998; Standards Australia 2002; Toth 1999; Victorian DHS 2003). Respondents also indicated that the majority of the attempted data linkage activities were successful in terms of the resulting data quality.

Limitations of the research

The study was limited to public sector, acute care facilities for several practical reasons: (i) to contain the scope and timeframe of the research within reasonable bounds; (ii) because private hospital data are not publicly available from the Victorian DHS; and (iii) there are time-consuming and onerous consent requirements for accessing private sector data. Acute separation data from the 2002-2003 financial year were used in sample selection because data for the 2003-2004 year had not been finalised by the DHS at the time the study commenced. The issues of privacy, confidentiality, and security of PMI and EPMI data were not addressed in this study.

Conclusions and recommendations

The results of this applied research are sufficient to inform the HIM profession and senior managers of Victorian public, acute healthcare facilities of a variability in PMI data quality maintenance and management. If the Victorian healthcare industry is to facilitate the sharing of health information in the future, then state-wide strategies are needed to address the identified lack of common practice. Furthermore, initiatives are required, to address the lack of resources faced by facilities awaiting strategies such as HealthSMART, to provide solutions to existing PMI-related problems.

A clear conclusion is that healthcare facilities in Victoria would benefit from the creation and implementation of state-specific data standards and PMI best practice guidelines similar to those of South Australia. These guidelines should be based on existing health information best practice publications such as Australian Standard AS 5017:2002 and the NHDD, and take into consideration the features and recommendations of other established projects. It would also be beneficial to establish a working party for this development, and to incorporate formal consultation with HIM professionals working in Victorian healthcare facilities, again along the lines of the South Australian model. Guidelines for the gamut of the PMI data quality activities noted in this research, such as standardised and centralised staff training programs, should be provided, with an expectation of mandatory participation. These publications should assist software vendors in providing adequate PMI software with probabilistic matching capability, extensive data capture features, and the capacity to produce sophisticated reports to support the monitoring of duplicate files.

The introduction of a unique patient identifier that could be utilised across public healthcare facilities in Victoria would facilitate record linkage activities. The authors are aware that this idea is encompassed in the HealthSMART strategy and, therefore, encourage the progress of this work.

Further research is needed to assess and compare this important aspect of health information management across other Australian states and territories, and in the private sector. It is evident that initiatives surrounding record linkage are being undertaken in other states, for example South Australia. More widespread research would enable a comparison of results to inform the Victorian facilities and, ultimately, to pave the way for more sophisticated, national linkages. It would also be valuable if, based on this and further research, HIMs were to establish threshold levels to assist in the monitoring of PMI data quality.

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