

# Researching hospital patient data to enhance operational management

Liza Heslop, Brendon Gardner, Dean Athan, Donna Diers and Catherine Taylor

## Abstract

For the purposes of funding and policy development, the Victorian Department of Human Services expects Victorian health care institutions to capture patient data at all levels. These data can be extracted from hospital information systems and potentially offer a business role within a health service organisation. However, there are many issues to be addressed at the organisational level in order that operational directors can be enabled to use hospital data to solve health service operational problems. In this paper, we discuss some of those considerations and give practical examples of how patient data can be used for research and management purposes.

**Key words:** *health services research; casemix analysis; hospital data systems; health information management; patient management*

## Fundamentals of data mining for health services research

Data mining is a process used to identify trends and patterns in data by analysing and extracting data contained within a database. It is a process of assembling data, presenting it to a data mining software program, interpreting it and applying the results to new problems. Such data are of interest to hospital operational directors for several reasons; for example, they could be responsible for prejudices or misconceptions, but could also inform operational decisions (Lee et al, cited in Liao & Embrechts, 2000).

Although useful data are available for health services research, the processes for extracting and preparing data, and the decision-making processes about actions that might be taken, can be time-consuming aspects of the research process. Although many textbooks and journal papers provide information on data mining processes, many do not sufficiently elaborate the difficulties faced by health service managers and health researchers.

Before commencing health services research using clinical data, researchers and managers need to know what inpatient data are collected in Victorian hospitals, and how to access these data. As part of the mandatory inpatient state-based reporting system, large volumes of data are collected for each inpatient episode. These data include patient demographics, country of birth, Indigenous status, criteria for admission, admission type and source, type of care, financial classification, length of stay, diagnoses and procedures (up to 24 of each), diagnosis related group, intensive care hours, hours of mechanical ventilation, coronary care hours, intention to re-admit, and discharge destination and type. These data are reported to the Victorian Admitted Episode Dataset (VAED). The VAED is an invaluable data source for researchers, health planners and policy makers, but it is at the local level that it can be used for enhancing patient management. There are also several other mandatory data reporting systems in place, such as the Victorian Emergency Minimum Database (VEMD), the Client Management Interface (CMI), the Elective Surgery Incentive Scheme (ESIS), and the Critical Care Inter Hospital Transfer (CCIHT), all of which are excellent data

sources for research, benchmarking and other types of data analysis.

Data mining begins as an inductive process whereby key research questions are defined, given knowledge of the data available. The next step in this process is to explore whether the research questions can be illuminated by data mining procedures, whether data are available to illuminate the problem, whether the data analysis is useful for reporting purposes, and what potential knowledge can be gained from the process.

A team based at Peninsula Health has undertaken several hospital data mining studies. Peninsula Health is located in Victoria, Australia, and services metropolitan and semi-rural areas. The region encompasses 900 square kilometres and is at least an hour's drive from the Melbourne CBD. The resident population of Peninsula Health's catchment area is a multicultural community of just under 300,000 people. The region's higher-than-average number of elderly residents requires a special focus on aged-care services. The steps that may be useful for health service personnel who wish to pursue data mining processes using hospital data are summarised in the next section. They involve the creation of a multidisciplinary team, development of strategies for health information management services, and provision of education to health service personnel. Finally, we report some data quality and data capture issues and describe some experiences of extracting and preparing data.

## Steps for undertaking data mining in health services research

### Creating a multidisciplinary data mining team

Before delineating key questions that can potentially be answered following mining of hospital data, it is essential to form an integrated team of appropriate personnel who have an interest in clinical data mining methodology for application to hospital best practice models. Our group (hospital data mining group) consists of clinicians, university personnel, health information management personnel, and hospital finance officers. This group is currently undertaking hospital-

based research using data mining procedures, and works with a unit at Peninsula Health that is responsible for reporting activity and financial information using health data. In 1998 this unit commenced operating with two part-time staff members who were employed as part of the Performance and Health Outcome Measurement Unit. It provided the first consistent, activity-based reporting within Peninsula Health. As the work of the unit progressed, staff observed that opportunities for improved reporting could be enhanced by combining the staff of this unit with those in existing clinical costing and Combo PC budget areas. The new unit is known as Management Information Services (MIS), and staff of MIS are responsible for providing reports and developing software that facilitates access to activity, financial, and human resource measurement information.

### Developing strategy and future directions for Management Information Services

A primary goal of MIS at Peninsula Health is to provide timely and accurate information and to disseminate that information to relevant groups such as the Board of Directors, Executive Directors, Clinicians, Department Heads, Cost Centre Managers, and Financial Officers. Making available the desirable amount of easily accessible information to these groups is crucial for operational decision making. The reliance of MIS staff members on electronic methods has increased, and the technologies available have expanded to allow access to more complex data.

Part of MIS's development has been to encourage the use of best practice and industry-standard technologies at each level of development. A Microsoft SQL server is a failsafe, central store of data; XML is a universal data transfer mechanism; OLAP provides for complex and interactive data analysis; and web browsers allow for intranet report distribution. The toolset used to process complicated business logic for presentation to hospital groups includes Microsoft's .NET family of products.

These technologies provide a number of benefits to Peninsula Health:

- Standard Microsoft technologies that make use of existing assets like Office and Windows Server are used.
- Reporting systems are integrated with multiple systems which access central cost centre and general ledger and payroll information.
- Reporting of clinical and quality indicator type is now efficient and timely.
- There are familiar ways of reporting and manipulating data using web browser.
- Key performance indicator type data are easily accessible.

Key examples of established application of these technologies at Peninsula Health are:

- weekly productions of key performance indicators and other activity and clinical performance based reporting mechanisms.
- the integration of all MIS reporting (desktop and web-based) with our central cluster/aggregate/cost centre data store using SQL Server.

In addition, the online-reporting web site allows users to view expenditure reports archived to July 2000, with the ability to 'drill down' to journal-level detail. Reports can be viewed via a web browser, and printed or analysed using Microsoft Excel. This system replaced the e-mail distribution of expenditure reports, and was developed using Microsoft Active Server Pages, Visual Basic and XML.

Budget Online 2003 was created based on an online budget entry system developed by MIS in 2002. The specifications of the older system were reviewed and a list of improvements was drawn up. There was an opportunity to build the new intranet web site using .NET technology with the latest development tools, and utilising data access components optimised for SQL Server as a back-end and support for XML. The simplicity of the application – a report screen and a data-entry screen – meant that the project could be finished in the time specified, built using three-tier architecture and integrated with existing enterprise data stores, such as cost centre distribution and general ledger data. Online Reporting Version 2 (still in development) extends Version 1 and will provide greater decision-support capabilities. This is achieved through drill-down capabilities for salaries to employee level, and for consumables to purchase order level.

The immediate and forthcoming developments of MIS include the completion of an Online Reporting Version 2 which will replace much of the current e-mail distribution of cluster and cost centre reports. This will provide a single intranet location for access to a wide range of current and historical reports, delivered in easily navigated format, with the ability to target specific data and investigate expenditure to its source. A salary reporting system, which will replace the current legacy system, is also being developed. This system will also include automated interfacing directly to the SAP payroll data store.

The research and effort spent on the creation of existing systems will be used in the development of future web-based and desktop applications. Such applications will make use of an improved developer toolset in Microsoft .NET, industry-standard technologies and best practices, and efficient data access principles. This includes the use of SQL Server data warehousing using OLAP, XML as a universal transfer mechanism, and a structured development methodology. The end objective of employing these technologies is to empower clinicians and key decision makers with up-to-date and relevant information concerning the ongoing operational and decision-making needs of the hospital.

### The need for clinical education

The power of casemix information for hospital clinical and management reform cannot be realised until user-friendly methods of teaching are developed. It has been common for casemix education to focus on payment issues, but health service personnel require knowledge of how casemix information can be used 'at the coalface'. If clinicians and operational managers know how to access and manipulate the clinical and operational data elements within a casemix information system, they can better understand, monitor and

change practice. Part of our work at Peninsula Health has been to develop workshops for clinicians and managers at all levels, as well as for finance and information system personnel. These workshops have been conducted at several conferences as well as through Monash University. The teaching model we have developed is underpinned by a living database of real hospital discharges based in AN-DRGs; the data are not meaningful without a context. We review the production and function of casemix (from which DRGs and AR-DRGs descend), ICD coding and DRG grouping rules. For demonstration purposes, we provide participants with a modified demographic and clinical dataset and a simple manual that translates ICD codes and AN-DRGs. We assist participants with reading the data and answering clinical queries. For example, nursing managers have difficulty in describing the work of their units in clinical management terms. If they have knowledge of data within hospital casemix information systems they can use that knowledge to make management decisions concerning the nursing unit. The content of the workshop demonstrates that the large quantity of data available within a healthcare institution provides operational managers with a very powerful and functional patient management tool.

### Data quality and data capture

Peninsula Health uses Combo PC as the clinical costing and casemix analysis system. This incorporates the VAED with patient-specific departmental activity data throughout the hospital (for example, pathology, radiology and ward activity) to produce a comprehensive hospital-activity and patient-costing database which can be quickly and readily accessed.

Capturing an appropriate clinical population can be a difficult part of the data mining research process, requiring consultation with financial, health information and operational managers. There are several research papers that give practical advice on how to access patient data in a way that will give operational directors, such as nurses, helpful information to effectively manage care in the acute care sector (Diers, 1999; Bozzo, Carlson and Diers, 1998; Diers et al 1998; Pollack & Diers, 1994). Health information managers or clinical costing managers are able to determine exactly what data are needed to answer a clinical query because they know what data and indicators are available to assist with answers to any query. When capturing relevant clinical data, we needed to ensure that it could be reliably extracted. Multiple methodologies were investigated, but we elected to work in conjunction with our software supplier to develop a suite of data extracts that could provide us with the data in a reliable way and in a timely manner. These data were then stored on a separate server and manipulated using Microsoft Access.

### Experiences of extracting data and preparing data

Once the data are extracted, research can commence by clarifying key research questions and exploring the data. For example, we have recently undertaken a study which explores high-cost users as a patient

group. High-cost users are separations or patient discharges from hospital that generate extremely high costs when compared with average cases in the same diagnostic related group (DRG). The high-cost users group was studied to highlight patterns across key variables derived from clinical, financial and operational categories. The purpose was to support operational management strategies for patients identified as high-cost users. One of the key research questions was: What DRGs are inappropriately represented in high-cost groups?

Prior to commencing the data mining exercise on high-cost users, various methodological questions required clarification, for example:

- What groups of patients should be excluded?
- What procedures should we adopt to identify high-cost users?
- What criteria will be used to qualify the group as 'high-cost' users?
- What methodological procedures are best adopted to identify high-cost users?
- What criteria can be used to qualify patient groups as high-cost users?
- What variables are associated with patients who fall into high-cost status?
- What key variables are associated with high-cost users as a group?
- How do high-cost groups compare with groups identified as not high cost?

Some time was spent discussing these points and the various options and directions that were taken for the study.

### Examples of data manipulation

Following are examples of the types of patient data manipulation that have enhanced patient management at Peninsula Health over the last 2 years.

1. Development of a bed management strategy to maximise bed occupancy. This was achieved by investigating admission and discharge practices, including an analysis of the day-of-week admissions and discharges, as well as analysis of elective and emergency admission rates.
2. Modelling a new High Dependency Unit in contrast to maintaining high dependency patients in the Intensive Care Unit. This required the modelling of costs, workload and other factors such as throughput and casemix.
3. Investigation of the community benefit of developing an angiography service at the hospital by analysing the population's morbidity and current service patterns.

Some research demonstrates clinical applications for improving decision support for health and nursing managers (see, for example, Munsch, 2002; Heslop, Elsom and Parker, 2000; Taylor et al, 2001). Nurses can use the data that the health information managers collect, code, report and analyse in many ways. Consider, for example, the following proposition: Baragwanath (1998) has argued that reduced length of stay (LOS) for patients may be associated with increased nursing resource consumption, but there has been little empirical evidence to support this argument. Using

hospital data there is the potential to establish relationships between LOS and nursing activity. Further studies are needed to clarify the relationship between nursing activity and length of stay. Diers and Potter (1997) sought to improve nursing practice patterns in a nursing unit which is funded under casemix. Nursing care requirements are complex in wards in which a wide range of cases are treated. Casemix data offer nursing managers a description of the casemix of their particular unit. Diers and Potter (1997) were able to restructure the casemix of the ward, and subsequently found that nursing resource consumption improves when nurses have enough similar clinical experiences to become expert at their work.

## Conclusion

Access to, and knowledge of, standard hospital information systems is a relatively recent factor in nursing inquiry. The harnessing and understanding of the large quantity of data available within a healthcare institution provides a very powerful and functional patient management tool, which is currently underutilised by many clinicians; there are numerous standardised databases throughout the health industry. Various 'stepping stones', such as understanding what is collected, how to access the data and formulating clinical questions to which the data can respond, provide a firm basis for manipulating patient data to enhance patient management.

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## Liza Heslop RN, PhD, MN, BAppSci, BA

Director  
Centre for Health Services Operations Management  
Monash University  
Frankston, VIC  
Tel: +61 3 9904 4639  
E-mail: Liza.heslop@med.monash.edu.au

## Brendon Gardner, BAppSc (MRA), MHA

Lecturer  
Centre for Health Services Operations Management  
Monash University  
and Director  
Information Management, Peninsula Health  
Frankston, VIC

## Dean Athan, BSc (Chemistry), BEc (Accounting), DipBA

Lecturer  
Centre for Health Services Operations Management  
Monash University  
and Manager and Developer  
Information Management  
Peninsula Health  
Frankston, VIC

## Donna Diers, RN, PhD

Adjunct Professor  
Centre for Health Services Operations Management  
Monash University  
Frankston, VIC

## Catherine Taylor

Director, Actnow Services