Developing a linked administrative database of health service utilisation by the aging population of Metropolitan Perth

PK LOH, JENNY STEVENS, AND MARK DONALDSON

PK Loh is a lecturer at the Department of Medicine University of Western Australia (UWA) at Royal Perth Hospital (RPH), Jenny Stevens is the Senior Social Worker in Department of Geriatric Medicine (DGM) RPH and Mark Donaldson is the Head of DGM at RPH.

Abstract

The increasing use of health services by the older population has placed significant stresses on the health system of Western Australia. This is a report of the development of a linked administrative database of health resource utilisation by the aged population of metropolitan Perth. Hospital administrative databases linked to clinical or administrative databases of other health providers are reviewed. Length of stay data is linked to aged care assessments, referrals to nursing homes and community services. The linked databases approach allows the study of resource allocation and can pinpoint systemic stress in aged care. It is a tool for reducing the duplication of services, the pressure on beds in health institutions, and cost by improving efficiencies.

Background

The aging population is increasing in Australia (Gray, 2001) with increasing demands on health care services. The population over 65 has increased progressively from 9% of the population in 1976 to 12% in 1998. It is projected this will increase to 18% by 2021 and 23% by 2041.

The increasing health requirements of the aging population have placed a significant stress on the health system in Western Australia (WA). They include an increase in demand for acute services and difficulties in returning to independent community living after illness.

There are frequent ambulance bypasses in the Emergency Departments (ED) of the 3 main teaching hospitals. For example, ambulances were redirected away from a tertiary hospital emergency department for up to 20 hours according to a West Australian newspaper report (Perkins, 2000). There are exit blocks in the wards of the tertiary hospitals with patients waiting to go to nursing homes after developing permanent disability from their acute illness or exacerbation of a chronic illness. The Premier of Western Australia was reported quoting up to 150 aged people were waiting in Perth public hospitals for a nursing home bed in December 2001(Tickner, 2002). The average waiting time for a residential care bed was 52 days.

It was therefore an appropriate time to study admission data linked to databases of service utilisation to start resolving the problem. This paper describes the definition, development process, utility, benefits, pitfalls and an example of the practical relevance of linked databases.

Linked databases

The linked database attempts to resolve the lack of intelligence on health resource utilisation by the older population in WA, which may exacerbate resource demands on the WA health system. The Head of Department of Geriatric Medicine and the Director of Medical Services at Royal Perth Hospital started a project linking administrative and clinical databases of health care organisations to gather information on this problem. This would give a snapshot of resource utilisation by aged care services at the Royal Perth Hospital (RPH) or other metropolitan teaching hospitals and the nature of their clients' health resource utilisation.

Aims

The aims of the project were to develop a database relating to the use of health and support services by older persons with continuing disability. This would determine patterns of resource utilisation and provide feedback to improve efficiency of services provided. Furthermore, it would develop an understanding of the use of electronic databases in health management decision making. The information gained would help develop policies which minimise the reliance on tertiary hospital services by older patients and patients with chronic disabilities.

Development of databases

The first real medical databases were collections of bound medical notes originally introduced at the St Mary's Hospital in 1907 (Kurland & Molgaard, 1981). The medical notes recorded medical progress but did not record the utilisation of health services within and outside the organisation. Hospitals and other health service providers have maintained separate records of service utilisation initially on paper then on electronic databases. Ultimately, linking all the databases will develop a client database that integrates existing institution based, sector based provider and funder based records that cover all contacts of the clients with the health system. The end result would be the linking of all elements of health and support services information to develop a single integrated record.

The Integrated Health Record and Information System (IHR) for individual medical records has already been proposed and the House of Representatives Committee recommended a system in 1997. However, the linked database is a compilation of an individual's health service utilisation record scattered throughout the health care system. These individual records are then compiled to provide an aggregate database for studies in epidemiology, resource utilisation, outcome measures and projections of future service utilisation, finance and administration. Similar to the IHR the linked database is not necessarily the gathering of all the information to a single location; rather it is the ability to access and link pre-existing information. The linked database will also include information on the utilisation of support services by the clients.

Hobbs and McCall proposed the first routine medical record linkage in Western Australia in 1970. Record linkages bring together a single individual's records from different sources. There are 3 basic steps to this process (Gill et al, 1993). Firstly, blocking of records from different sources pertaining to the individual. Secondly, matching related records. Finally, linking the matched records so they can be analysed as one.

This three-step process is performed at the Department of Health of Western Australia and individual data from all the participating organisations is de-identified. The use of database linkages for research or management purposes is uncommon due to the need for inter agency cooperation and the needs for long term planning. To date there are few examples of comprehensive record linkage systems mainly in the United Kingdom and Canada (Mount et al, 2000; Acheson, 1967; Kendrick, 1993; Melton, 1996; Roos et al 1993). The Western Australian experience started in 1995 with the construction of the WA Health Services Research Linked Database (Black et al, 1995).

The benefits of linked databases

The linked database will benefit individuals by improving access to health services and reducing duplication of assessments for access to community services as a result of better coordination by different agencies.

The benefits of linked databases to the health care system are better informed policy developments (Mount et al, 2000); improved resource allocations and management (Mount et al, 2000); provision of outcomes and cost benefit analysis for community services; the availability of demographic data for management and epidemiological purposes. Finally, it can be used for monitoring and projections of residential care requirements. These points are discussed below.

Policy development

Linked databases may benefit policy development in aged care services by providing timely data without the need for expensive prospective studies. The need for residential care by patients who developed significant disability after admission to hospital may have precipitated an exit block in Perth's teaching hospitals, culminating in a crisis with bed shortages. This crisis lead to cancellation in elective operations and Emergency Department bypasses due to an inability to admit patients into hospital beds. The development of policies to combat this problem will be supported by data gathered from linked databases.

Resource allocation and management

The allocation of scarce community resources to areas of stress within aged care services can be facilitated by research from linked databases. Community services such as shower assistance and medication prompts are essential services for families coping with dependent older relatives. They allow senior citizens the opportunity to remain independent for longer periods in the community. The linked databases will identify where services have been allocated and how to manage the transition to other coordinated programs and initiatives, and may be a useful tool for managing improvements in existing programs. Care Awaiting Placement (CAP) programs need to be managed locally but are coordinated and funded regionally or statewide.

The resource allocation issues can be a challenge and providing real time information problematic. Analysing the utilisation of services may help us design a more responsive system that can meet local demand and is less dependent on traditional block funding. The Health Department of Western Australia announced it would allocate $17 million to develop EDs to overcome the 'ambulance diversion problem' (Tickner, 2002). Perhaps the solution, with evidence from linked databases, for the older patients would be to develop hospital in the home programs, acute community visiting teams that can refer direct to hospitals, early discharge programs and access to respite care.

Outcomes and cost benefit analysis for community services

Linked databases can be mined for performance indicators. The benefits are outcome driven funding initiatives. Furthermore, these initiatives can be considered and trialed on models based on the database. To date there is no DRG equivalent funding initiatives for social support and community health services. Linked databases can be used to assess the utilisation of services in ED by older patients, particularly those who frequently represent and those from residential care. Indicators of use and access to ED from linked residential care databases may help with resource allocation.

Demographic data for management and epidemiological studies

Linked databases from a large cohort of metropolitan older patients provide useful epidemiological data. The development of clinical pathways for rehabilitation and restorative care requires epidemiological data. In many of these tertiary hospital based clinical pathways, such as for fractured neck of femur patients, community support and discharge planning are key elements in appropriate and timely discharge. These pathways require evidence, from many sources to determine the most appropriate gateways through the pathway for timely progress.

Monitoring and projections of residential care requirements

The projected rise in the cost of residential care can be better managed with appropriate and timely information from linked databases regarding its utilisation. At this stage there is no formal electronic nursing home waiting list. However, there is a research database on potential nursing home residents, which may be the forerunner of the electronically managed nursing home waitlist. At any moment there is no system to match the need for

nursing home beds to the potential occupants. Currently, each nursing home maintains a waiting list and notifies the appropriate prospective occupant when a bed becomes available. The forerunner of a centralised wait list system for residential care may be developed from linked database studies.

Implementation of linkages

Data linkages

It is important to develop more links that will allow the extension of the Western Australian Centre for Health Services Research Linked database. This database currently includes hospital in-patient statistical records, West Australian Mental Health Register, Cancer registry and death records from 1980 onward (Holman et al, 1999). Links to the Silver Chain database, the Aged Care Research and Evaluation Unit's Minimum Data Set (MDS) and the Mental Health Services register are being developed. Silver Chain (SC) is one of the largest providers of community nursing and personal care services in Western Australia. It has approximately 16000 persons registered for care at any one time and provides up to 30 000 episodes of care per year. SC maintains a computer-based register of the services utilised by its clients. The MDS is a database of all referrals to the aged care assessment teams (ACAT). The development of more linkages to other organisations in health care will increase the utility of the linked database project.

Technical aspects

The technological development of a linked database began in 1995 using two SPARC 1000 central processing platforms with 28Gb of internal and external hard disk storage (Holman et al, 1999) The technical team was lead by Dr Bass using Automatch software package. Unique health care identification numbers were not used by all the databases to be linked in Western Australia. The linkages between the different databases had to be identified using probabilistic matching. The core datasets are matched based on hospital unit record number, surname, first given name, initial, date of birth, sex and residential address. In addition to computerised matching with name compression algorithms, clerical matching was undertaken for possible matches using additional information to complete the matches. The database constructed is a real time database with new records being added to the linked datasets. This virtual database has a 'chain of links' structure developed by Dr Bass that allows it to be reconstituted to the state of linkage from any examination on a previous date (Holman et al, 1999). This allows the database to be reconstructed as it was last examined, which is important as new records are being continuously added.
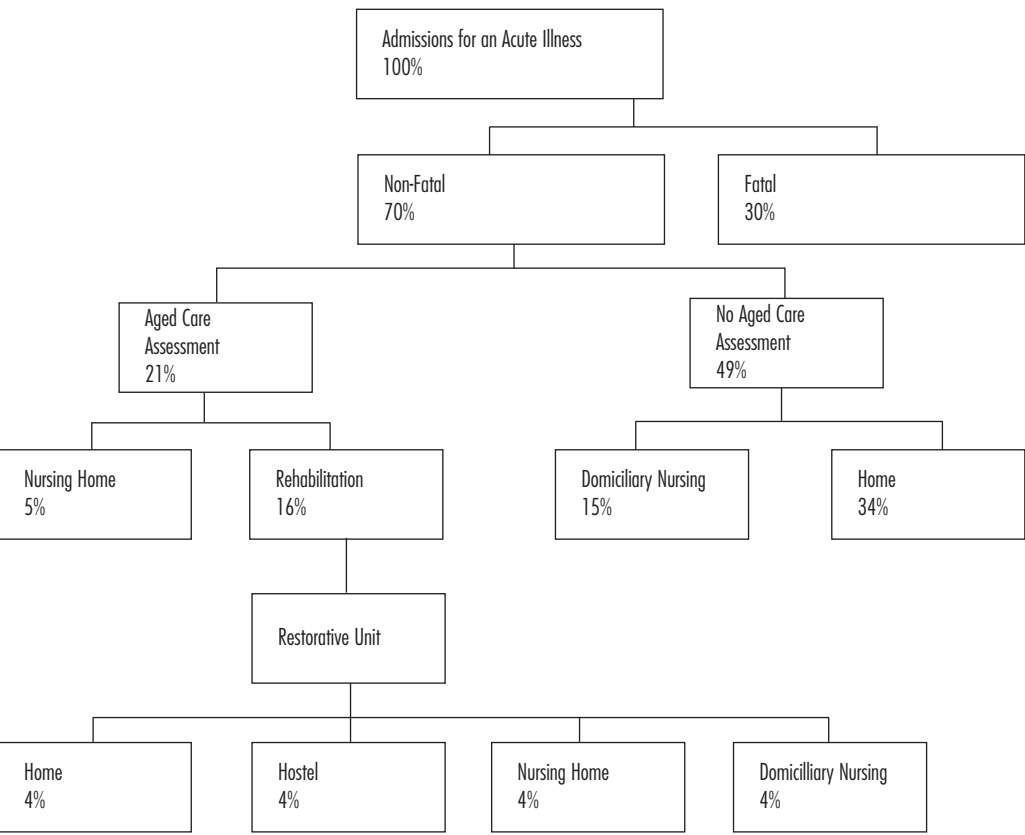
The initial linked database master file to which additional datasets have been added is the hospital morbidity data system. This is the largest dataset to which other datasets have been linked. A demonstration file of linked 1990-1994 data covering hospital morbidity, mortality and mental health services was created. There were 1,233,728 links for 886513 individuals created on this demonstration (Holman et al, 1999). Statistical analysis can be performed on this data using the Statistical Analysis System (SAS) or the Statistical Package for the Social Sciences (SPSS). The quality of the hospital morbidity data can be assessed by a sampling technique. A sample of data from selected linkages was compared with results of a careful clerical assessment in September 1996. The proportion of false positives (invalid links) and false negatives (missed link) were 0.11% (Holman et al, 1999) in the sample obtained from the linked database.

Methodology of an aged care study

The sample from a large linked database can be selected by time of admission to hospital. For example, the index year for data and linkages to be reviewed is selected as 1996. This is then the total number of cases, in the Perth Metropolitan area, which presented to RPH or hospitals in that year. The presenting diagnoses to hospital such as heart failure, stroke, or falls can be selected for study from the hospital morbidity data. The data from the hospital in-patient statistical data is then linked to the aged care minimal data set (MDS) to determine how many of these individuals require ACAT assessment in that year. The hospital statistical data also provides information on length of stay (LOS) and mortality in hospital. In addition data can be linked to the death registry and nursing home database. Diagram 1 shows a flow chart of the possible outcomes of an acute geriatric

illness studied in a selected year to Perth metropolitan hospitals from the linked database. Figures are for illustrative purposes only and provide an idea of the trends to discharge from hospitals with possible disruption leading to exit block.

Diagram 1: Outcomes of Linked Database Study

```
                          ┌─────────────────────────┐
                          │ Admissions for an Acute Illness │
                          │ 100%                    │
                          └─────────────────────────┘
                    ┌──────────────┴──────────────┐
          ┌──────────────────┐          ┌──────────────────┐
          │ Non-Fatal        │          │ Fatal            │
          │ 70%              │          │ 30%              │
          └──────────────────┘          └──────────────────┘
        ┌─────────┴─────────┐
┌──────────────────┐   ┌──────────────────┐
│ Aged Care        │   │ No Aged Care     │
│ Assessment       │   │ Assessment       │
│ 21%              │   │ 49%              │
└──────────────────┘   └──────────────────┘
  ┌──────┴──────┐         ┌──────┴──────┐
┌────────────┐ ┌────────────┐ ┌────────────────┐ ┌──────────┐
│ Nursing    │ │ Rehabili-  │ │ Domiciliary    │ │ Home     │
│ Home       │ │ tation     │ │ Nursing        │ │ 34%      │
│ 5%         │ │ 16%        │ │ 15%            │ │          │
└────────────┘ └────────────┘ └────────────────┘ └──────────┘
                │
       ┌────────────────┐
       │ Restorative Unit │
       └────────────────┘
   ┌────────┬────────┴────────┬────────┐
┌────────┐ ┌────────┐ ┌────────────┐ ┌────────────────┐
│ Home   │ │ Hostel │ │ Nursing    │ │ Domicilliary   │
│ 4%     │ │ 4%     │ │ Home       │ │ Nursing        │
│        │ │        │ │ 4%         │ │ 4%             │
└────────┘ └────────┘ └────────────┘ └────────────────┘
```

Utilising the aged care data (Table 1)

The patients, from the linked database, with the diagnosis under study are stratified depending on the LOS in hospital. They can then be divided based on outcomes such as ACAT referral, Nursing Home recommendation, Silver Chain referral and mortality. The percentage of patients who had these outcomes can be compared.

In a linked database study of a selected geriatric condition, as the length of hospital stay increases, the percentage of patients having outcomes requiring services and support increased. For example, as the length of stay increased more patients were recommended for nursing home care. The percentage of patients, within each stratum, recommended for nursing home increased for patients who had an extended LOS (greater than 31 days) compared to those who had a short LOS (1-10 days).

This increasing trend provides information regarding the care requirements and cost of care. The referrals to ACAT increased with increasing LOS. The percentage increased from those who had a short LOS (1-10 days) to those with the extended LOS (greater than 31 days). This suggests the need for early referral to ACAT in long staying patients to facilitate discharge planning and consideration for residential care. The earlier these patients

are referred to ACAT during the discharge planning process the earlier they will be on the residential care wait list. This is a step towards reducing the exit block of older disabled patients in teaching hospitals. The figures in Table 1 are for illustrative purposes only. They show the trends described.

Table 1: Example of outcomes stratified by length of stay for an acute condition

Length of Stay (Days)	% Aged Care Referral	% Nursing Home Recommendation	% Domiciliary Nursing Referral	% Died
1-10	6	3	5	1
11-20	12	6	10	2
21-30	18	9	15	4
> 31	24	12	20	8

Problems with linked databases

Confidentiality and safety of health care information
The presence of a linked database would collate extensive personal information on an individual ranging from medical diagnoses to Medicare and social security numbers. This information would be of interest to third parties such as insurance companies and other agencies (government and non-government) that previously did not have a complete picture of the individual's health (Carter, 2000). The interest of these agencies may not be solely confined to legitimate public health interest. Although the data is coded, stored within firewalls and protected by passwords, the possibility of glitches and leaks are not impossible. Despite precautions, there always remains the risk of electronic records being accessed inappropriately - intentionally or unintentionally. It is unlikely that concerns about misuse will ever be completely addressed by technology alone, as we need to contend with the inconsistencies of human nature. The debate about 'privacy' and 'public good' is ongoing. However, for linked database projects an ongoing focus on the aims, accountability by the users of data and ongoing vigilance may minimise the problems with privacy.

Technical difficulties with links
Technical difficulties in linked databases will result in delays and may result in inaccuracies with the data. The technical problems can happen anywhere along the linkage process previously described. It is also possible the incidence rate and prevalence of chronic conditions obtained from linked administrative databases may not be accurate. The size of inaccuracies has been studied by comparing the incidence and prevalence of chronic end stage renal failure (CRF) between linked data from the WA Health Services Research Linked Database and the Australia and New Zealand (ANZDATA) dialysis and transplant register (Brameld, 1999). The latter is a purpose designed disease register. The WA Linked Database counted 7% less incident cases of CRF and 7% more prevalent cases. The ad hoc linkage allowed the two databases to compare cases and the linked database identified 97% of cases on the ANZ register and the ANZDATA correctly identified 90% of cases on the linked database. The linked database is dependent on the coding and data entry standards of the organisations maintaining the databases to be linked.

Discussion

The possible utility of linked databases in realigning service provision for WA aged care services was highlighted by John Hunter Hospital (JHH) experience in Newcastle, New South Wales (Graham, 2001). JHH had problems providing beds for patients admitted through ED. The principal cause was the number of older patients occupying acute care beds whilst awaiting residential care. A review of the management processes indicated delays and inconsistent approaches when assessing patients requiring residential care. The residential

facilities delayed hospital discharge, as they often had to check for inaccurate assessment of the care needs of potential residents. There was also a lack of differentiation between patients who required fast or slow stream rehabilitation. To overcome these problems the Hunter Health Executive and JHH Executive staff collaborated with health professionals to implement changes. These changes, reported by Graham (2001), were early functional assessment of older patients, with disability, for rehabilitation to facilitate discharge planning. These changes included the development of admission criteria that would only accept patients who would benefit from rehabilitation. There was the development of a Geriatric Evaluation and Management (GEM) unit for the management of acute medical problems to focus on functional recovery and early discharge home. There was also the establishment of a transitional care unit to facilitate slow stream rehabilitation for return to the community with support or placement in residential care. Finally, the development of patient care plans in hospital using the same classification systems as residential facilities to accurately reflect the level of care required in residential facilities.

These strategic initiatives resulted in a reduction in the length of stay of older patients at JHH awaiting placement by 16%. There was also a 50% reduction in the time to signing of the Commonwealth application form for residential care approval.

The information required to evaluate a JHH plan in the East Metropolitan Region of Perth is available piecemeal within different organisations. Teaching hospitals may not want to subscribe to such an extensive strategic plan without further analysis. Therefore, the utility of linked database studies within major hospitals and large health care organisations in the Perth metropolitan area.

The JHH experience was an example where outcome orientated clinical studies with linked databases can help in planning and monitoring the success of re-engineering of aged care services. If the JHH experience can reduce the number of older patients being admitted through ED and the exit block from care awaiting placement patients it will have a significant impact on hospital and health services management. In order to carry out a project similar to JHH in Perth a linked database of health service utilisation by the older persons in the community would be helpful. RPH has recently launched a GEM unit and the linked databases will assist in analysing its effect on Aged Care service provision. Without a linked database the information needs to be accessed from many individual databases, compiled, collectively analysed and reporting is less timely.

In conclusion, linked databases can be subject to manipulation if inappropriately used, maintained or policed. However, the health service linked databases are a powerful management tool if used appropriately with the right safeguards.

Acknowledgements

References

Acheson ED 1967, *Medical Record Linkage*, Oxford University Press, London.

Australian Bureau of Statistics 1999, *Census*, Australian Federal Government, Canberra.

Black CD, Burchill CA & Roos LL 1995, The population health information system: Data analysis and software, *Medical Care*, vol 33, pp127-31.

Brameld KJ, Thomas MA, Holman CD, Bass AJ & Rouse IL 1999, Validation of linked administrative data on end-stage renal failure: application of record linkage to a 'clinical base population', *Aust New Zealand Journal of Public Health*, vol 23, no 5, pp 464-67.

Carter M 2000, Integrated electronic health records and patient privacy: possible benefits but real dangers, *Medical Journal of Australia*, vol 172, pp 28-30.

Commonwealth Health and Aged Care 2001, *Commonwealth Funded Residential Aged Care Services in Western Australia*, Western Australian State Office, Commonwealth of Australia.

Gill L, Goldacre M, Simmons H, Bettley G & Griffith M 1993, Computerised linking of medical records: Methodological Guidelines, *Journal of Epidemiology and Community Health*, vol 47, pp 316-9.

Goldswain P, Reberger C & Wallace G 2002, *Proposal to develop hospital based aged care services for Bentley Health Service*, Rehabilitation and Aged Care Integrated Clinical Service, Department of Health, Western Australia.

Graham J 2001, *Placement transition smoother for frail elderly*, Australian Resource Centre for Hospital Innovations (ARCHI) Net News {www.archi.net.au}, Accessed 10 December 2001.

Gray L 2001, *Two year Review of Aged Care Reforms*, Department of Health and Aged Care 2001, Commonwealth of Australia, Canberra.

Holman DJ, Bass AJ, Rouse IL & Hobbs MS 1999, Population-based linkage of health records in Western Australia: development of a health services research linked database, *Australia New Zealand Journal of Public Health*, vol 23, no 5, pp 453-459.

Hobbs MST & McCall MG 1970, Health statistics and record linkage in Australia, *J Chronic Disease*, vol 23, pp 375 – 81.

House of Representatives Standing Committee on Family and Community Affairs 1997. *Health on Line*. Report into health information management and telemedicine. Canberra: Commonwealth of Australia, Available at http://search.aph.gov.au.

Kendrick S & Clarke J 1993, The Scottish record linkage system, *Health Bulletin* (Edinburgh), vol 51, pp 72-9.

Kurland LT & Molgaard CA 1981, The patient record in epidemiology, *Scientific American*, vol 245, no 4, pp 46-55.

Melton RJ III 1996, History of the Rochester Epidemiology Project, *Mayo Clinic Proceedings*, vol 71, pp 266-744.

Mount CD, Kelman CW, Smith LR & Douglas RM 2000, An integrated electronic health record and information system for Australia? *Medical Journal of Australia*, vol 172, pp 25-27.

Perkins J 2000, Concern as ambulances warned away, *The West Australian*, Wednesday 4th October 2000 page 6, Perth, Western Australia.

Roos NP, Black CD, Frolich N, Decoster C, Cohen MM, Tataryn DJ, Mustard CA, Toll F, Carriere KC & Burchill CA 1995, A population-based health information system, *Medical Care*; vol 33 DS, pp 13-20.

Tickner L 2002, Action urged on aged care, *The West Australian*, Wednesday 2nd January 2002 page 17, Perth, Western Australia.

Tickner L 2002, $17m hospitals plan unveiled, *The West Australian*, Monday 7th January 2002. Perth, Western Australia.