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Casemix and information systems

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Casemix refers to a mix of patients classified in some way. It describes a system which groups patients by predetermined factors into clinically meaningful and resource homogenous groups to describe the hospital or health service product (a measure of output). A number of patient classification (casemix) systems have been developed for various purposes. The casemix system used by Australian acute care hospitals to define their 'products' is the Australian National Diagnosis Related Groups (AN-DRGS). Similarly patients may be grouped to represent homogeneity in terms of nursing resource usage. Such classification systems are therefore 'nursing casemix systems' and are used to describe the nursing department's products which are components of the hospital products. Other departments may also use a system to classify their patient services on the basis of resource usage in order to identify other product component costs.

With a definition of the health service product it is possible to relate all inputs and processes to these products to support decision making at all levels within an organisation. This is highly desirable in a climate where accountability, efficiency and effectiveness are valued. Inputs consists of buildings, labour resources and supplies as well as the health status of individuals seeking health services. Processes consists of all that happens to and on behalf of the recipients of health care. Relating inputs to processes, outputs and outcomes for the purpose of performance evaluation requires effective and timely integrated information systems. Thus clinical and costing data need to be captured relative to intermediary and final products however defined.

Information systems associated with casemix may be described as grouper software, costing systems, morbidity systems, hospital information systems, departmental (feeder) systems, including nursing workload monitoring systems, pathology, organ imaging systems and executive information systems. In fact most if not all health information systems may be related to casemix in some way.

Definitions associated with casemix influence system specifications. For example an episode of care differs from the length of stay. An episode of care relates to the type of episode where each type refers to its own casemix system. For example AN-DRGs apply to acute patients only. Hospital services are now further differentiated into acute, sub-acute and non-acute type of patients. A patient may be discharged from one episode of care to another within the same hospital length of stay. In other words the term 'episode of care' is no longer

used to mean the period from admission to discharge, except where the patient has only one episode of care during the period of hospitalisation. Patients may also be transferred from one hospital to another within the same episode of care.

Actual costs are influenced by the quality and quantity of all resources used to provide patient care towards achieving the desired outcome. As in industry, once costs are identifiable one can explore the most cost-efficient methods or processes to be employed to achieve the desired outcome. Through the examination of the production relationships (inputs relative to outputs) one gains an understanding of those elements which can explain cost variations between hospitals. Outputs need to be defined not only in terms of the product as expressed by casemix but also in terms of outcomes. According to Iezzoni (1987 p.135) a "useful outcome measure would be sensitive to subtle changes in health status or well-being, thus permitting clinically meaningful evaluations of the impact of medical interventions". The linking of quality to outcomes was explored by Shamian et al (1994). These authors state that "an outcome is a measurable product, it is the state or condition of an individual as a consequence of health care" (p.1). This implies that outcome measures have agreed definitions and can be captured by information systems which is an essential prerequisite to the evaluation of service cost effectiveness. An understanding of the production relationships is necessary when using cost data as a basis for management decision making aimed at improving both efficiency and effectiveness of services provided.

Casemix is now well established in Australia having been placed on the national health care services agenda as part of the 1988 Medicare Agreements. The Casemix Development Program funded by the Commonwealth Government commenced in Australia in 1989. In 1991 the Commonwealth re-directed the focus of its Casemix Development Program towards implementing a national casemix infrastructure. This program was renewed under the 1993 Medicare Agreements in accordance with a five year Casemix Strategic Plan as approved by the Australian Health Ministers' Advisory Council in late 1993. The strategic plan for the casemix development program has the following priorities:

- continued development, adjustment and enhancement of AN-DRGs and the development of classification systems for all other types of hospital care.
- development and refinement of Australian cost weights and service weights and improvement of hospital information systems to determine costs and set prices
- development and use of improved payment systems with the aim of ensuring the efficient delivery of high quality health care.

Clinicians are actively involved in casemix activities through the Australian Casemix Clinical Committee (ACCC).

The Casemix Development Program aims to provide the health care industry with a nationally consistent method of classifying all types of patients, their treatment and associated costs, in order to achieve better management, measurement and payment of high quality and efficient health care services. The Government has recognised the need for consistent tools to assess quality, compare costs and understand the relationships between inputs and outputs for some time. These initiatives have had major implications for health information systems used for data collection and processing to provide management decision support at multiple levels of decision making.

DRGs and AN-DRGs

AN-DRGs are modelled on the Diagnosis Related Groups (DRG) system which has been used as a basis for allocating resources via the United States Medicare prospective payment system since 1983. The DRG patient classification system was developed during the 1970s by Fetter et al (Fetter 1985a p.107) at the Yale School of Organisation and Management and the School of Yale School of Public Health "to attempt to discern and identify discrete kinds of illness for which one could expect, in a statistical sense, a relatively consistent response from any one physician or any one set of physicians with respect to the diagnostic and therapeutic services ordered to deal with that". On the basis that physicians are primarily responsible for determining the process and hence the cost of patient care, this grouping was used in an attempt "to establish the statistical similarity and significances of differences in resource consumptions and patterns from one kind of patient to another" (Fetter 1985a p.107). Physicians are considered to be accountable for approximately 80% of total hospital expenditure (Young and Saltman 1983).

To classify an episode of care into a DRG the following information is needed after discharge:

- Principal diagnosis
- Significant secondary diagnosis
- Age of patient
- Gender of patient
- Surgical procedures performed
- Type of discharge

This information is normally available from the discharge summary which is completed by the treating doctor after discharge. Medical record administrators code the conditions treated and the procedures performed using the International Classification of Diseases - 9th Revision Clinical Modification (ICD-9-CM) system. These codes plus the other information are then used by grouper software to classify the in-patient episode. Advantages of grouping are that there are considerably fewer case types (products) than ICD-9-CM. The DRG system has been widely tested and the data needed for classification purposes are now available from every medical record in every Australian hospital. This is largely the result of improvements in infra structure, mainly funded and facilitated through the casemix development program.

The first version of DRGs contained 327 groups, these were later expanded to 383 groups based on the International Classification of Diseases, Eighth Revision (ICDA-8). The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) was published in 1978 and produced a greater refinement in diagnostic coding and a wider spectrum of diseases and disorders (Hornbrook 1982 p.87). Subsequently an entirely new set of DRG definitions were developed resulting in 467 groups using the ICD-9-CM coding which has around 12,000 diagnosis codes and 4,000 procedure codes. A fundamental change was to organise the major diagnostic categories by organ system (rather than aetiology) since this follows the organisation of medical specialties. This became the First Revision and was used for prospective payment in the United States in 1983. This version was also used for many of the original Australian DRG studies.

In 1986 the Second Revision was adopted by US Medicare and this version was used widely in Australia. Later in 1986 the Third Revision was implemented in the US and Victoria. The Fourth Revision, consisting of 475 DRGs, came in use late 1987. In October 1988 the Fifth Revision, consisting of 477 DRGs was introduced. In addition to these versions New York State has extensively modified version 4 for use in its own payment system, the National Association of Children's Hospitals and Related Institutions (NACHRI) in the USA developed an extension of the DRG system and Yale University developed a Refined DRG (RDRGs) system (Palmer and Reid 1989). In 1991 the New York State version 8 was issued. It has 614 DRGs (Verco 1991). By 1990 there was no common version in use in Australia. However by 1992 the Australian Casemix Clinical Committee (ACCC) had developed Australian National DRGs (AN-DRGs) in conjunction with 3M who also developed the related software to aid the grouping of cases into AN-DRGs.

Versions of the DRG classification as used by the US federal government agency, the Health Care Financing Administration (HCFA) responsible for the operation of US Medicare and other health care programs, are referred to as HCFA DRGs such as HCFA- 3 introduced in 1983, HCFA-4 etc. The tenth version applied in 1993.

Each year amendments are made to the ICD-9-CM code lists. The later additional diagnosis codes relate mostly to HIV infection and there have been many new codes for surgical procedures (Palmer and Reid 1989). A new version, the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10), is now available and plans are under way to introduce its use in Australia and the use this as the basis for the AN-DRG version 4. These many changes have implications for information systems, especially when there is a need or desire to make comparisons over time. It means that some form of mapping between the different versions must be possible. Furthermore the number of digits used for the codes determines the size of data fields. Thus an addition of one digit is likely to have major cost implications for information systems.

Australian DRG development

A proposal by the Commonwealth Department of Community Services and Health to the Australian Health Ministers Advisory Council (AHMAC) in early 1990 led to the endorsement of the establishment of a national standard casemix classification system. Another related Commonwealth initiative was the National Health Strategy Review. An important component of this review was to assess the use of casemix for funding purposes.

An interim clinician steering group, now the ACCC, was established to coordinate the development of a standard inpatient classification method for use in Australia. The ACCC is of the view that "a more clinically precise classification and one reflecting Australian Health Care will be more effective for use in funding and in clinical management" (Verco 1991). Other casemix working groups were responsible for formulating all project requirements, including education, cost weights, finance design, documentation standards and conventions, and information technology. Changes needed to be consistent to ensure that Commonwealth policy objectives were met.

Major difficulties identified affecting the empirical data analysis, were the absence of a "single authoritative sample of Australian patient discharge data that uniformly represents the practices of Australian health care providers" ..., "resource measures throughout Australia do

not consistently include the cost of services rendered" plus "standards and conventions for documenting DRG data elements differ across the States". (McGuire 1992 p.5). Notwithstanding these difficulties the AN-DRGs version 1 released in 1992 were said to be "a synthesis of state-of-the-art US DRGs with clinical modifications that better characterise the organisation of acute care in Australia" (McGuire 1992 p.7). AN-DRGs version 2 became available during 1993 and were used for the second National Costing Study. Version 3 is expected to be in use for 1994/95. Later versions are expected to be based on ICD-10. AN-DRGs have a higher level of grouping consisting of 23 Major Diagnostic Categories (MDCs).

A variant of the AN-DRG was developed to define neonates by age to suit all neonatal in-patient episodes defined either by age under 29 days or by the presence of a neonatal diagnosis or both. There are 30 neonate AN-DRGs. Paediatric sub-groups are also defined as the Paediatric modified DRGs (PM-DRGs). The split is at age 10 in AN-DRGs, and usually at 18 in other variants of the DRG system. As the use of casemix systems is expanding the need for new classification systems is emerging. It has become apparent that the same principles may be applied to other, non-hospital health services. As a consequence casemix systems have and continue to be developed for the extended care sector, ambulatory care, and a variety of community health services.

New Australian casemix classification systems

The Australian Ambulatory Classification (AAC) system was developed during a national study in 1992 as a result of the National Ambulatory Casemix Project (NACP). It was developed for use in all Australian hospitals, excepting specialised paediatric hospitals, and has been proposed as the national standard. Paediatric hospitals use the Australian Paediatric Ambulatory Classification system (APAC) which was developed concurrently with the AAC system. Western Australia has developed the Urgency Related Groups (URGs) classification system to categorise all services in hospital emergency departments, including those to patients who are admitted directly from the emergency department.

The National Non-acute Inpatient Classification project led to the devepment of the Non-Acute Inpatient (NAIP) classification system in 1992. This system suits inpatients whose condition necessitates institutional but not necessarily acute hospital inpatient care. It is also used for patients who require only maintenance nursing, and those who are awaiting placement to care in another setting. It is used when an episode of care cannot appropriately be classified by AN-DRG. It defines 19 classes.

Overseas developed casemix systems

Activities of daily living index is a measure of overall dependence based on tasks such as toileting, eating, dressing, bathing and ambulation. This is used by the Resource Utilisation Groups (RUGs) and may be referred to as the RUG ADL index. RUG-3, which has 43 final classes, was introduced into US nursing homes in 1992 as a basis for funding. Another casemix classification system for nursing homes developed in California is the California Long Term Care Classification (CLTC) system. Episodes of rehabilitation in the USA are categorised into Function Related Groups (FRGs) or the San Diego Rehabilitation Acuity Instrument may be used. Also used is the Functional Independence Measure (FIM) to measure patients' functional abilities and carer burden.

Adjacent Diagnosis Related Groups (ADRG) are clusters of similar diagnoses or procedures, which may be split using age or clinical complications (CCs) to form final classes in the DRG classification system. The All-Patient Diagnosis Related Groups (AP-DRGs) is a variant of the DRG classification developed originally for use in New York State to support a DRG-based payment system. Originally known as New York DRGs.

The United Kingdom has developed its own DRG variant called Healthcare Resource Groups (HRGs) to reflect the view that not all cases are diagnosis related. Also the UK uses ICD-9, not ICD-9-CM to code diagnosis. Procedures are classified using a UK classification system, OPCS. The Information management Group and the Centre for Coding and Classification have initiated a National project to create a comprehensive multiprofessional thesaurus of clinical terms associated with the further development of the Read codes. These new clinical codes were originally developed for primary health care and are now expanded for use throughout the UK health system. Grouping to HRGs will be possible directly from the Read codes eliminating the need to associate Read codes with ICD-9 and OPCS codes. Canada has developed Case Management Groups (CMGs) to describe medical conditions treated.

Ambulatory Care Groups (ACGs) were developed in the USA to categorise episodes of ambulatory care provided in a period of time, typically a year. Ambulatory Patient Groups (APGs) is another system also designed in the USA to classify ambulatory episodes of care both in and outside hospitals. Other similar systems are the Ambulatory Service Weighting System (ASWS) and the Ambulatory Visit Groups (AVGs). A higher level of grouping of patients with similar diagnoses is the Major Ambulatory Diagnostic Categories (MADCs). Patient care episodes in emergency departments may be classified into Emergency Department Groups (EDGs) developed in the USA. Several ambulatory casemix classifications, including APGs use the Current Procedural Terminology version 4 (CPT-4) classification of medical services which is used mainly for billing purposes in the US. CPT is roughly equivalent to our Commonwealth Medicare Benefits Schedule (MBS).

Also developed in the USA is a casemix classification system, the Psychiatric Patient Classes (PPCs) for psychiatric acute inpatient episodes as a refinement of psychiatric classes in the DRG system. There are two levels of classification: 12 psychiatric diagnostic groupings (PDGs), which are then further split into the 74 psychiatric patient classes. There are many other older patient classification (casemix) systems developed for a variety of purposes such as the Computerised Severity of Illness Index (CSI), Disease Staging, the Acute Physiology and Chronic Health Evaluation (APACHE II), the Medical Illness Severity Grouping System (MEDISGRPS), Patient Management Categories (PMCs)

Using casemix for funding purposes

The use of casemix for decision making, frequently centres around costing and financing aspects of the health system. Details of the financing of health services tend to change over time and differ between Countries, and between Australian States and Territories. There are also differences between the private and public sectors. One needs a good understanding of the issues, principles and details associated with both casemix data requirements and funding formulae adopted in order to use specify system requirements and to use casemix data optimally for decision making purposes.

One should not confuse a patient billing model, as is used in the United States of America known as the prospective payment system (PPS), with a budget allocation funding model. The former is most suitable to reimburse costs on an individual patient basis such as for the care of individual private patients in either the private or public sector. It uses the fee for service principle as it incorporates a price per DRG, an outlier definition, a payment rate and an outlier payment pool as well as adjustments for those cases which do not fit the DRG classification. A patient billing model is generally speaking not suitable for Australian public hospital funding, although elements of the model are relevant for some purposes. For example for the transfer of funds between the States for cross boundary flows of public hospital patients, for compensable and repatriation patients in public and private hospitals. A budget allocation model on the other hand uses casemix as an input into the allocation of aggregate funds from a State or Territory health authority to individual public hospitals.

According to Palmer (1994) formulae using casemix as a basis for funding public hospitals are heavily influenced by existing relationships between the funders and the providers of hospital services and on the policy objectives of the government or other funding agencies. This model is used to distribute a fixed pool of funds between all hospitals administered by the funding authority. That is there is a ceiling referred to as ‘capping’. A number of modifications may be made to this model depending upon the policy objectives. For example Victoria used a seperate funding pool to adjust individual hospital budgets based on the number of cases serviced (throughput) as an incentive for hospitals to reduce public hospital waiting lists. In other words rather than using one pool, several pools may be created. Each funding pool is then exclusively used for the purpose for which it was created, for example teaching or rural hospital or defined geographical area funding pools. The latter is population based.

The Victorian government was the first to introduce output based funding as from July 1993. This government now considers itself to be paying for services provided to hospital patients instead of providing funds to service hospitals. Hospitals receive a fixed annual grant plus a payment based on the hospital’s casemix as defined by AN-DRG. Additional grant allocations are made for extra costs associated with teaching staff and for aspects of hospital care for which current AN-DRGs do not apply. New accountability processes were introduced through Health Service Agreements between the Victorian government and hospitals (H&CS 1993).

South Australia introduced casemix based funding in an ongoing operational environment a year later using its own formula as explained by Filby and Gaston (1994). The Queensland Government aims to do so in July 1995. Details are provided by Read (1994). In Tasmania casemix information is incorporated within its Resource Allocation Model (TRAM) mainly used for costing inter-regional patient flows. Western Australia has adopted the purchaser-provider model of funding and uses casemix data for operational purposes and for purchasing health care services. This is explained by Anderson (1994).

New South Wales uses casemix as a component of its resource allocation formula used to fund all health services. This was designed to reallocate resources on a population and needs basis. An additional allocation based on a comparison of AN-DRG cost weights and total occasions of service is made to teaching hospitals to cover additional expenses incurred for teaching. According to Newman (1994) NSW Health has formally endorsed the use of casemix based funding models within Area Health Services, districts and hospitals.

Before any casemix system can be used as a basis for funding one needs to place a value on each category. These may be expressed in relative (weights) or absolute (price) terms. Either way it is desirable to have some idea of actual costs incurred per category. There are essentially two different approaches which may be used to cost the products of health services. The first is referred to as clinical or product costing. It uses a bottom up approach by capturing data about all cases and the many services provided during an episode of care. The second option is to use what is referred to as cost modelling. In Australia the Yale Cost Model is used for this purpose. It is a top down approach where all costs associated with the organisation's service provision are distributed to the products, however defined using this model which expresses the relationships between costs, activities and casemix products. These distinctions are not clear cut as some cost modelling does occur in the first approach depending on the available detail of cost information. Furthermore the use of product costing by some organisations provides more accurate data to be used by the Yale Cost Model enabling others to more confidently use this method.

It is essential that cost centre and accrual accounting is in place to use either method. These cost centres facilitate the tracking and allocation of costs by product. It should be noted that some hospitals also undertake teaching and research, the products of which require their own definition. Some services are provided which do not directly contribute to the organisation's main product. For example a hospital kiosk or the local meals on wheels service are provided for other organisations or individuals. Such activities do provide additional hospital income and as such are part of the financial system.

Product costing

Accounting costs are expenses classified by a standard chart of account. Costs are then allocated directly or distributed according to a uniform method of apportionment and transformed into unit costs by dividing the total costs by consistently defined and generally accepted units of service or work units. The sum of these units may be referred to as the departmental workload. The costs incurred in providing clinical services are directly related to the workload generated by patients, the staff provided to service these needs, and to materials used.

For example nursing labour resource usage, is measured in terms of staff category (skill mix), the associated hourly cost and time. Staff hours required to produce a defined product, represent the labour resource input cost. The cost per staff hour varies relative to staff category, shift and day of the week worked. The latter two variables are dependent on penalty and shift allowances. Thus both staff mix and rostering practices influence nursing costs. Other clinical services have similar variables influencing costs.

The time taken by a worker to carry out an operation or to provide a service is influenced by the nature of the work to be performed, the skill and knowledge of the staff member, the circumstances within which the work is performed, the methods employed, and the perceived time available. Actual costs will reflect all of these factors, including inefficiencies. To arrive at a cost per product, there is a need to first identify all resources used per unit of work relative to each product. Secondly the associated costs are identified. Thus to cost departmental services, accounting systems need to be merged and related to information pertaining to:

- all labour resources used by that department
- actual services provided per patient type (intermediary products or work units).

These costs are then related to the output measure in use, eg. AN-DRG. In this manner defined input costs relative to defined outputs are traced. According to Picone et al (1993 p.26) valid and reliable measures of nursing service must be established before the cost of nursing services can be determined. These comments apply equally to other departments. The importance of the validity of the source data used for the costing of such departmental services is directly related to the proportion contributed to the total product cost. This will vary for each category. Because nursing costs comprise a large proportion of the total costs for most AN-DRGs, the tracking and accuracy of nursing costs are very important.

Various methods may be employed to establish departmental and product costs. Different allocation methods of the same data result in different final costs per product. Another cost accounting issue to be aware of is the fact that many health care agencies continue to predominantly use a cash accounting system. However with the introduction of casemix based funding they are now switching to accrual based accounting. Cash accounting systems tend to exclude costs associated with the depreciation of capital costs as no cash transactions are associated with these costs. However such items purchased from the recurrent funding allocation are included.

Palmer (1991 p.4) noted that by 1991 it was only feasible to apply costing methods to inpatients. The reporting of non-inpatient activities required considerable improvement before these other products could be costed. This is slowly occurring.

The Australian National Costing Study, first conducted during 1992 and now regularly updated, identified the following component costs for each AN-DRG: Ward Nursing, Medical, Pathology, Imaging, Theatre, Drugs, Critical care, Allied health, Medical and surgical supplies, Overhead allocation, Patient catering and Other. (KPMG 1993). Individual organisations may decide to break this down further into individual responsibility centres or departments. Such breakdowns or unbundling of total costs is also dependent upon the funding formula in use. For example if the organisation is funded seperately for intensive care or medical services or non acute patients or outliers etc., then there is a need to identify costs associated with the components of every output measure in use. This has implications for casemix information system development.

Tracking departmental costs by output measure(s) serves a number of different purposes.

- To support departmental managers in their decision making
- To establish a price for departmental services provided.
- To support corporate management in their decision making
- To establish a cost or price per product
- To develop service weights for use by the Yale Cost Model

Costs per product could also be used as the dependent variable to improve homogeneity of any casemix system in use in respect of resource usage. In any event the data set used for such purposes must be easily available, well standardised for consistency and be reliable.

The development of departmental service weights has ususally begun in the form of a research project. The first in Australia was conducted by Stoelwinder et al (1986) in conjunction with a clinical costing project. The development of National Service Weights for Organ Imaging, Pathology, Operating Rooms and Critical Care was undertaken during 1994. National Nursing Service Weights were originally developed during 1992/93 and are undergoing continued refinement. Note that service weights refer to relative departmental costs per AN-DRG and cost weights refer to relative costs per product.

Palmer (1991 p.8) discusses the importance of the 'marginal cost' concept. The estimated marginal cost of each AN-DRG may be used by some funding formulae. It is a concept developed by economists and represents the cost of one more unit of output. That is, the increase in the total costs associated with the treatment of an additional patient. The average cost which includes fixed and variable costs is normally greater than the marginal cost. Marginal costs are not synonymous with variable costs.

The quantification of any departmental workload requires the measurement or estimation of labour resource usage from which a model is developed. The model then continues to be used as a proxy for that workload. Departmental workload monitoring (feeder) systems are a prerequisite to product cost accounting. Nursing is the single biggest department contributing to the total product cost.

Costs versus charges (price)

The determination of hospital charges, needed when using a patient billing model as a basis for funding hospitals, is not necessarily based on an analysis of actual costs. Pricing policies may be arbitrarily determined or be based on a number of alternatives (for example full cost, cost plus etc.). Most of the US literature which refers to costs per DRG use the terms "costs" and "charges" interchangeably. Consequently it has been difficult at times to identify whether the costs referred to are actual costs or charges. This is further complicated by the fact that in some instances charges do in fact reflect actual costs incurred per patient, or alternatively they reflect an average cost per patient type, however defined.

There is therefore little consistency in charge structures between hospitals in the US. Intra- and inter facility cost comparisons are distorted when charges are used to reflect costs (Young, Carson and Lander 1986 p.70). In addition there are a number of reasons why the total charges for individual cases in any AN-DRG will vary between hospitals. These include hospital pricing policies, demand and supply conditions in each local area, level of graduate medical education in the hospital, differences in practice patterns, variations in the quality of care, hospital care and availability of specialised facilities (Pettengill and Vertrees 1982). Differences in charges between hospitals therefore do not necessarily reflect differences in economic efficiency. In Australia this applies to private health care facilities. Similar comments could be made about differences in costs between Australian public hospitals.

Finkler (1982) adds another caveat when comparing costs between hospitals in his discussion regarding the use of charges data as a proxy for costs. He demonstrated that ultimately the cost assigned to the patient may be wrong due to allocation methods meant to secure maximum reimbursement rather than to accurately reflect resource consumption on a department by department basis. He differentiates between the identification of how a hospital spends its dollars (economic cost) and how much a hospital must collect to break

even (accounting cost). He states that the use of an accounting cost as a proxy for economic cost is "of questionable value due to the potential differences between economic and accounting cost for a specific patient," (p.107).

The issue of price setting for Australian public hospitals is that of deciding which cost to use in the funding formula, the national average cost or the State average cost or the hospital group average cost etc.? It is also important to know exactly what this cost covers. In other words what is in the bundle? Are medical costs or capital costs included? Thus a basis for pricing each product must determined. Should prices used for resource allocation be determined exclusively on the basis of costs? Given that the health budget is finite there may be a need to cap total expenditures which may be achieved in a number of different ways. Decisions regarding these questions are reflected in the funding formula adopted which in turn determines information system data requirements including reporting specifications.

With casemix based funding of Australian public hospitals there may be an associated desire to maximise income and minimise costs by manipulating casemix. This possibility raises ethical issues which one will need to be aware of.

Clinical (product) costing systems

The first clinical costing developmental work in Australia was performed in conjunction with McDonnell Douglas Information Systems. The original development site has since switched to the Transition clinical costing system. This fully integrated computer software system was developed in Boston, USA to support hospital cost accounting, case mix and product line management, simulation and budgeting (Transition Systems Inc.1989) and is now widely used in Australia. It views hospital activity as a three-stage production process referred to as intermediate products, such as procedures and services provided in the patient-care process, end products or individual patient cases typically defined by AN-DRG and product lines which are strategic groupings of the services a hospital provides. Product lines may be defined by clinical service or case type or any other characteristic which defines the 'strategic business units' of a hospital used for marketing, budgeting or strategic planning purposes.

These three stages reflect the differences in control and management. The first stage is controlled by departmental managers, the second stage by medical practitioners and the third stage by executives and administrators. Departmental costs are identified as intermediate products under the control of departmental managers. At the departmental level fixed and variable costs are identified and the intermediate products are defined for subsequent costing and for the development of standard unit costs, using any costing methodology. Also indirect costs are allocated as defined by the user. Cost and volume interfaces are automatically created, productivity and management reports may be generated and trends can be analysed. Furthermore it is possible to generate comprehensive cost variance analysis reports, conduct flexible budget variance analysis and departmental cost simulation. Many other management reports are available relative to product lines and end products.

The system employs two kinds of cost accounting systems. Process cost accounting at the intermediate product level, because these units are perceived to be repetitively produced within each department using well-defined cost standards, and actual volumes of production. Job order cost accounting is used at the end product or patient case level as each patient case

is different representing a unique bundle of intermediate products. For this purpose the exact numbers and types of intermediate products are usually captured.

Feeder data for any user-defined period of time, such as patient dependency data reflecting nursing costs, are loaded into the Department Cost Manager (DCM) module of the Transition system to form the information base. Thus the user decides how to identify and build intermediate products such as nursing services. Cost information is provided by the hospital's general ledger system and/or payroll data via an interface, created by the end user, that maps cost data to the DCM. The DCM is designed to be a standard cost accounting system where budgeted volumes and costs are used to generate standard unit costs. Actual volumes and costs are captured by the system which is then able to produce comprehensive variance analysis reports. Actual unit costs by intermediate product, such a nursing cost per patient day, may be arrived at by spreading actual costs to these products based upon actual volumes and the relative value units used to develop the standard costs. Other similar systems, such as Panacea, Trendstar, and others are in use.

Clinical costing systems provide detailed management information. This consists of the best possible estimate of actual costs incurred relative to defined products such as AN-DRGs. Some cost modelling is required. A criticism and issue for consideration is whether the cost of obtaining this type of detailed information is justified relative to the benefits of greater precision. It is relatively expensive to implement and maintain a clinical costing system. It takes some time from implementation before meaningful information becomes available. Furthermore clinical costing relies on the use of feeder systems such as nursing workload monitoring systems and other departmentally based systems in order to provide detailed information which is useful for all levels of decision making. These feeder systems use Relative Value Units (RVUs) as a basis of distributing total departmental costs on a per patient basis. RVUs are determined by the intermediary product description in use. For example nursing work units are defined by the nursing workload monitoring or patient dependency system in use. These RVUs should not be confused with those used as the basis for developing service weights by AN-DRG even though the same data are used for both purposes.

Relative value units

Actual costs need to reflect how departmental resources available at the time, are actually distributed between patients. That is, costing methods need to account for situations where the staff available is less than the workload measurement systems suggests is needed and vice versa. Nursing workload monitoring systems are crucial to providing the data from which all nursing costs are obtained. The validity of these systems is dependent upon the work measurement technique used to develop the system and the way in which this is applied to generate a staffing formula. Such systems automate the process of converting patient characteristics and care requirements into staff hours and relative values, in terms of nursing resource usage, between patients.

Relative value units (RVUs) are measures of relative resource usage or relative costliness of defined units. When used to cost nursing services then a unit may be defined as a patient/nurse dependency category. Such relative values were incorporated into Australia's first clinical costing system developed by Stoelwinder et al (1986). They reflect the relative values of departmental work units. On the other hand a RVU was defined by Picone et al

(1993 p.112) as a scale of items of service and measure of relative costliness of each item. A nursing RVU was defined as nursing minutes per episode of care. Here the RVUs referred to the aggregate nursing intensity per patient discharged defined by AN-DRG which was related to a similar unit. More specifically they achieved a model of relative nursing intensity by regressing nursing time on length of stay to produce a beta weight (Picone et al 1993 p.59). Note the difference between the two, the former is used as a basis for cost modelling used by clinical costing systems, a bottom up approach, and the latter is ultimately used for cost modelling using a top down approach.

Feeder systems do have other uses. For example patient dependency systems are concerned with using patient characteristics and care requirements as a means of predicting nursing resource needs. As such they are management information systems used mainly by nurse managers, although they may be used for a variety of other purposes, including strategic management, planning, for costing nursing services, development of nursing service weights, and to assist in the management of length of stay by case.

Service weights

Service weights are the end product of a process which begins with work measurement or the estimation of relative departmental work unit values. For example in nursing, work measurement is used to develop a nursing workload monitoring system from which relative values are derived which in turn are used to develop nursing service weights. A service weight is a measure of the mean cost of the specified service for any patient type relative to the mean cost for all patient types. When service weights are derived from data collected within one hospital, then they reflect a weighting applicable to that hospital only. Standard weights for national use may be developed by pooling such data from a randomly selected group of hospitals. The National Costing Study (1993) used service weights first from the US and later Australian developed service weights, for their cost modelling approach. Individual hospitals may have a desire to compare their own resource usage, expressed in terms of time, costs or service weights, against national standards to evaluate performance.

Yale cost model (YCM)

Cost modelling does not require the detailed data collection described above; instead the relationships between costs, production processes and hospital products are modelled. Clinical costing is desirable to gain a better understanding of the various cost relationships per DRG. This does not imply that every hospital needs a clinical costing system.

According to Palmer (1991 p.10)

> “the YCM (Yale Cost Model) is the only feasible method of generating estimates of cost by DRG in circumstances where information about the costs or charges associated with individual patients is not routinely collected. This is (was) the case for all public hospitals and most private hospitals in Australia.”

The YCM evolved from the cost per case data set, referred to by Fetter (1985a) as one of two data sets assembled, which consisted of amounts charged to the patient per service category. The data did not represent costs of care but service charges. Fetter (1985 p.119) defines the cost allocation process used by the Yale team as “an absorbing Markov process to

find the accounts as a matrix in which the rows are the definitions of the accounts and the columns are the values of the accounts", the matrix is then inverted. The answer thus obtained is not in terms of the actual allocations but in terms of the matrix of coefficients which identifies the destination of every dollar. This is different from what is called a "stepdown process" which results in different answers depending upon the ordering of the stepdown used. According to Fetter et al (1977 p.143) "The usual step-down method will not suffice in this application since it is too costly computationally when one preserves the identity of the source accounts in the final allocations".

The YCM as described by Chandler (1988 p.221) represents a specific application of linear algebra to cost accounting in a hospital setting. This requires the definition of cost vectors and mapping matrices. Costs are mapped in a four step process from a hospital general ledger into AN-DRGs. First costs are allocated to cost centres, then overhead costs are allocated to the various clinical departments using a separate formula for each overhead cost. The third step consists of adjustments so that only costs for inpatient treatment episodes are included (some cost centres service both in and out patients). Finally costs from the clinical departments are mapped into AN-DRGs using charges as the allocation statistic. Nursing and some other departmental costs are allocated on the basis of service weights by AN-DRG for each clinical department. Reports can be prepared to give labour, materials, total, direct and allocated costs per AN-DRG, costs per bed-day per AN-DRG and costs per allocation statistic per AN-DRG. Other facilities for displaying the various allocation matrices in the mapping process are also available.

Palmer et al (1991 p.11) describe the YCM as consisting of several computer programs designed, first to allocate costs from each overhead cost centre to all patient care cost centres, second to allocate the total costs from the patient care cost centres to each DRG. The latter is described as "conceptually the most complex of the modelling processes". Palmer et al (1991) described the first use of this model in Australia. This cost modelling approach has since been used by KPMG Peat Marwick who were the successful tenderers for a Commonwealth government contract to undertake a National Costing Study to produce national cost weights by AN-DRG. This project began in February 1992. Cost weights for the AN-DRG Version 1 were released in August 1993. An extension of this project enabled the production of cost weights using AN-DRG Version 2. Chapter 4 of their report details the assumptions used in the cost modelling process.

Data inputs required by the YCM were summarised and listed by Palmer (1991 p.15) as follows:

- Expenditure by cost centre, classified by type of expenditure, for example, salaries and 'other', and by type of cost centre, for example, 'overhead', 'patient care'.
- Proportion of total resources used in each patient care cost centre which are associated with inpatient activities - the inpatient fraction of each of these cost centres.
- A statistic for each overhead cost centre such as total costs, staff numbers, floor space, bed numbers, bed days and admissions, which can be measured for all relevant cost centres and used to allocate expenditure by overhead cost centres to all patient care cost centres.
- Number of patients discharged and the number of patient-days, by patient care cost centre, for each DRG.

- Measures of relative resource use (service weights) by DRG for specified patient care and ancillary services.)

The validity of service weights, is very important for those hospitals which rely on using this cost modelling approach to cost their services by AN-DRG. The original YCM software has been modified to make it easier to use and is referred to as COSMOS. This microcomputer based software, complete with a users' guide for the model has been available to Australian hospitals since mid 1991.

Critical (clinical) paths

The management of length of stay by case has become an important component of managing within a casemix based funded environment where it is desirable to achieve a close to the average length of stay for each AN-DRG for every case. In project planning terms a critical path is the shortest possible length of time within which a project may be achieved. Critical or clinical paths in health care refer to multidisciplinary outcome based care plans. It requires the development of care plans on a case by case basis. They could be seen as an extension of the nursing care plan. Any care plan may be developed for each patient by the patient's care manager or a standard plan may be developed for each diagnosis using any product description such as the ICD-9-CM codes, or AN-DRGs. In any event such plans must be developed in consultation with all care givers. The use of clinical paths is expected to increase productivity, improve quality and control costs. Obsolete or unnecessary practises may be identified during the development process. Many hospitals have begun to develop clinical paths for high volume or high cost AN-DRGs to assist management to achieve this. Managing each case relative to the clinical path is referred to as case management.

Components of the path include a timeline identifying all required or anticipated interventions, outcome indicators against which progress may be monitored relevant to each discipline associated with the care, expected health status at the time of discharge, and individualised special needs. Once such plans are in place, one is able to monitor progress relative to the corresponding plan. This in turn permits the implementation of exception reporting. In other words any variation from the plan is noted and analysed so that corrective action may be taken as soon as possible. This is one way by which to manage individual length of stay and patient throughput as a whole.

It is an important tool for using casemix data for decision making. In particular it is useful for improving organisational efficiency and outcome effectiveness. It is a usefull aid to discharge planning and to identify areas for continuous quality improvements. The system also permits input from the patient and significant others providing a customer focus. It is a mechanism for achieving financial objectives without compromising the standards of care. The system will only work effectively if there is a supportive infrastructure which facilitates prompt problem solving when variations are noted. Such variations may be relevant to an individual patient only or they may reveal organisational wide problems.

Clinical path care plans are developed so as to achieve high quality care, effective communication between all disciplines, collaboration and optimum resource utilisation. The use of standardised care plans and terminologies will facilitate computerisation of clinical data and as a result improved capacity for clinical research at less cost than is the case with a paper based system. Case management on the other hand is about coordinating all activities

identified as required in the clinical path by a case manager. Nevertheless individual patients can be case managed in the absence of such a path by an experienced health professional. Nurses are ideally placed for such a role both in hospital and community settings, although in some instances it would be more appropriate to appoint an allied health professional. Case management is particularly cost effective for complex cases requiring many different types of services. Managed care, case management and clinical paths are being implemented in a number of Australian hospitals. There are some variations regarding the terminology and the use of the concepts outlined.

Information systems are now being developed to support this. These management activities are heavily dependent upon accurate and timely information. Historical data are used to first develop each clinical path and secondly to modify these as required. Continual patient assessments with feedback regarding outcomes lead to adjustments in services provided. There is an extensive body of literature on this topic.

Discharge planning

The process of discharge planning is closely linked with case management. O'Hare and Terry (1988 p.5) define discharge planning as: 'assessing needs and obtaining or coordinating appropriate resources for patients and clients as they move through the health care system'. The aim is to provide care continuity and to ensure that patients move through the system in the shortest possible time without adverse effects or the need for re admission. For many hospital cases this requires follow up care by community based services. Such care needs to be anticipated and organised in advance. Casemix-based funding provides an incentive for effective discharge planning.

Problems following discharge can occur where a patient or the family are unable to support daily living needs or do not understand directions for follow-up care or are unlikely to comply with advice given. Also the home environment may not be suitable for satisfactory self care. The home location relative to the treating centre may prevent care on an outpatient basis. Discharge planning must occur in consultation with the patient, the home based care givers where relevant, community based services and the health professionals providing inpatient care. An interdisciplinary approach is highly desirable. Discharge planning needs to commence on admission and in some cases prior to admission. Length of stay can be reduced only in conjunction with effective discharge planning.

Performance indicators

Indicators are signs, flags or signals, some of which may indicate desirable events where others indicate negative events. There are two types of quality performance indicators. The first is a rate based indicator which designates a level of occurrence; the second is a sentinel event. Rate based indicators are measured against predetermined acceptable thresholds, whereas sentinel events are so serious that no rate of occurrence is considered acceptable. Thresholds must be achievable. The Australian Council on Hospital Standards (ACHS) defines a clinical indicator as 'a measure of the clinical management and outcome of care' (Lawson & Collopy 1993). The ACHS assists medical colleges with clinical indicator development and health care facilities with its implementation. The use of clinical indicators,

which began with hospital wide indicators such as infection rates, unplanned re admissions and others, is now an integral part of the accreditation process.

Performance indicators are used to identify areas which would benefit from further investigation so as to improve performance and quality. Indicators are chosen as much for their data availability and collection feasibility, as for their relevance or established link with that which is desired to be measured. Where the quality of a service cannot be measured directly, it may be measured indirectly through the use of any number of indicators. Such indicators are pointers from which one may infer that the desired quality and outcomes were achieved. Alternatively they are used to indicate areas for further investigation. Workload and service utilisation statistics together with cost and outcome data may be used as indicators of quality.

There are a number of possible cost efficiency performance indicators for acute hospitals. Examples are: average AN-DRG weight, average inpatient unit cost, average length of stay, relative length of stay indicator, occupancy rate percentage of registered beds, total admissions, etc. None of these are very precise measures, but when compared over time or with other hospitals should indicate relative cost efficiency. Such indicators do not assist in explaining cost variations, rather they indicate where further investigation is warranted. These data need to be associated with outcome data, including patient satisfaction data, to get a sense of the quality and effectiveness of services provided.

The ACHS has established a database, the Inaugural National Clinical Indicator Data Evaluation System (INCIDE). As from 1993 this is being used to store all accreditation survey data to monitor the use and usefulness of hospital wide clinical indicators. It will also be used to observe trends in patient care on a national level and permit facility specific comparative performance evaluation. The intention is to link trend results to AN-DRG and other casemix funding.

Quality

Quality is defined in the Australian Department of Administrative Services and the Australian Office for Better Buying quality assurance policy (DAS 1992 p.3) as:

> Fitness for purpose, or conformance to requirements - the totality of features and characteristics of a good or service that bear on its ability to satisfy the user’s stated or implied needs at the time of purchase and during its useable life. Quality is not a synonym for excellence; a quality product is the one best suited to the purpose intended rather than the best that money can buy. An appropriate level of quality may be determined by balancing factors such as performance, reliability, cost, conseqences of failure, etc.

The quality of a country’s health service is generaly speaking assessed by the mortality rates and incidents of morbidity. These types of statistics are reported worldwide as death rates, major causes of death, life expectancy, live births, maternal and infant mortality rates and others. Such measures are indicators of ill health and provide the big picture. This information may lead to the identification of areas warranting closer scrutiny.

Another way of looking at quality is to examine what constitutes health. After all, health services aim to promote, maintain and restore health. The Australian Institute for Health and

Welfare defines health as social, economic, environmental, spiritual or existential well being. It also includes life satisfaction and other characteristics valued by humans. The World Health Organisation defines health as ‘a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity’ (WHO 1946). Thus a quality health service produces and maintains healthy people. Consequently measures of health may be used as indicators of quality.

At an institutional level quality may be measured in terms of the physical and organisational structures which contribute to or provide an appropriate environment for the delivery of quality health services. Another perspective on the measurement of quality is through the examination of processes, procedures and outcomes. Consumers are concerned with getting the most appropriate service provided competently by a qualified person at an optimum time and place, within an acceptable timeframe, which achieves what it is intended to do and which meets consumer expectations at every encounter. Thus quality is the degree to which the above expectations are met.

In a casemix environment we are concerned with more detailed information than has traditionally been available to begin to explain some of the variations which may be identified by the previously mentioned crude measures. Casemix as an output measure lends itself to scrutenising all planned and systematic actions as well as the management of the production processes associated with each case or case type. Quality assurance requires evidence that the services provided will or have been provided consistently in accordance with customer requirements. Thus if we assume that customers of the health service industry expect to achieve or optimise general health, then evidence of health status needs to be provided.

Health status

Health status may be defined in many different ways. The concept of health varies between people. There are a number of unresolved issues associated with quality measurement in health. The most significant ones are issues of definition. The concept of health is subject to many different interpretations. Perspective or the position from which we view health influences the definitions used. There are healthy but disabled people for example. Individuals will place different values on health. Concert pianists are likely to value their ability to hear and their dexterity more than others. Loss of function creates greater problems for some people than for others. The value individuals place on health stems from whether our state of health allows us to lead a fulfilling and satisfying life. For some this leads to more risk taking behaviour than for others. Thus individuals contribute to their own state of health. The value of any health status is also age related. What is effective functioning for some individuals is not for others; it depends on one’s perception and values.

So another significant issue regarding quality measurement is the fact that there are many variables which influence health. There is no obvious direct cause and effect relationship in many instances. According to Mooney (1986 p.31) health services have all the characteristics of uncertainty, irrationality, unpredictability, large monopoly elements, paternalism and important externalities. It is the combination of these factors which makes health care unique as a commodity.

Defining what is to be measured

Quality measurement in a casemix environment is concerned with the identification of inputs, processes and outcomes and the relationships between these. Input measures consist of raw materials and other resources made available. In the health care industry the raw materials are the people who seek health services. Admission policies are developed within this context and state the conditions within which a person may be admitted to receive specified healthcare services. A person's health status on admission becomes the benchmark against which outcomes may be measured.

A major factor influencing admission policies is the acceptance of risk. Risk assessment is about an analysis of the probability that a person considered for admission to a particular service will benefit from that service. For example existing health, severity of illness, personal support systems, socioeconomic and lifestyle status will influence the probablity of complications, adverse outcomes and extended length of stay.

Other inputs are buildings, equipment, materials and labour resources necessary for the delivery of health services. The quality of these and the environment in which these are used will influence the cost and quality of the services provided as well as health outcomes. So these factors need to be defined and measurable.

Casemix is used to define output measures. This system may be used for quantitative purposes. On the other hand outcome measures have a qualitative dimension. A useful outcome measure would be sensitive to subtle changes in health status or well-being, permitting clinically meaningful evaluations of the impact of medical interventions (Iezzoni 1987 p.135). Thus outcome measures could double as measures of health status on admission. According to Nash and Markson (1991 p.4):

> ....outcomes management, at its best, will systematically approach the topic of health care quality and costs through mechanisms that enable us to engage in ongoing analysis of the uncertainty that exists in the art of delivering high-quality medical care. We may not be able to predict with certainty the outcomes of care, but we should be in a better position to identify and prevent highly variant behaviour and to make more informed decisions.

Two types of outcome measures are required, disease specific measures to permit comparisons to be made between treatment options for individual cases or AN-DRGs, and generic outcome measures. The latter need to incorporate a means of evaluating the cost or benefit to the patient or client or society. Benefits may be defined in terms of functional improvement, pain relief, improved general well being, improved psychological outlook, improved quality of life, life years saved or increased life expectancy, improved employment opportunities or prospects, reduction in dependency on others or a reduction in the number of morbid days or ill health episodes. Some of these measures refer to life utility and functional health status which are outcomes of particular importance to individuals or their family members.

In order to use any of these measures in the future we will need to ensure that the data available permits such usage. This requires careful structuring of clinical data and knowledge, using a standard language throughout the health care system, enabling these data to be processed electronically. The meaning of standard data elements must be clear and universal.

Conclusion

The introduction of casemix (output) based funding has had major implications for health information system development. Most systems need to be linked to casemix in some way to maximise their usefulness. Indeed health information systems need to be fully integrated so as to enable timely, accurate and comprehensive information to be provided to support all levels of decision making, from the operational (clinical), to middle, executive and corporate management. In particular clinical and financial data need to be merged to enable effective management. Information systems need to be able to support decisions leading to the productive efficiency of the intermediate outputs and also support decisions which result in the effective utilisation of these outputs for the treatment and care of individual patients. Thus the measurement of organisational performance requires data collection which records both the utilisation of goods and services and expenditures incurred in their production.

Now that casemix defines health care products, all inputs, processes and outcomes need to be related to these products. This means that all systems now need to be patient or client focused although there continues to be a need for a departmental focus as well to support management decision making at that level. Clinical information systems must have a user interface that supports the needs of all clinical disciplines. Effective use of casemix based information systems permits the understanding and control of health service expenditures and requires a provisional casemix category assignment on admission to permit analysis of variance throughout the production process (episode of care or length of stay) enabling continuous quality improvement.

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