Variations in secondary care utilisation and geographic access: initial analysis of 1996 data.

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Introduction

Concerns about variations in access to health care services have been voiced for many years in NZ, and timely, equitable access to health care is a key health policy goal. Understanding these concerns, and meeting the Government's access aims, requires knowledge of how accessible services are, and how to improve accessibility. This paper reports on a project that represents a first stage in systematically understanding trends and variations in access to secondary health care in NZ. This project is the beginning of a larger programme of research on Exploring Trends, Variations and Policy Priorities to Improve Access to Health Care in NZ.

This paper reports findings from our initial analysis of one year's data (1996), focusing on the relationship between secondary care utilisation and distance to such services. It outlines our conceptual model of access developed for this project, our approach and initial results. We summarise key patterns, such as how utilisation rates vary across New Zealand using District Health Board (DHBs) areas, and examine utilisation rates for different gender, ethnicity, and age groups. We find that utilisation rates are far from uniform across DHBs and that, for the population as a whole, distance does not have a strong impact on hospital utilisation rates.

Background

A substantial international literature establishes frameworks for analysing access (Donabedian 1971; Aday and Andersen 1974; Penchansky and Thomas 1981; Goddard and Smith 2001). Aday and Andersen (1974), key contributors to this literature, distinguish between 'potential access' and 'realised access'. Potential access, here access, refers to the opportunity to enter the health system, that is, the availability of services. Realised access focuses on the relationship between service availability and the people who may avail themselves of services. Realised access is experienced at an individual level, but reflects a relationship between a number of factors including health policy, individual and population characteristics, and delivery systems. Realised access is more commonly referred to as 'utilisation; utilisation is the term we use here.

Measurement of access remains difficult. In practice, much attention is paid to the utilisation of health care services, as a proxy measure of realised access. Researchers have identified factors affecting utilisation and estimated the strength of links between these factors and utilisation. Penchansky and Thomas' (1981) model describes five dimensions of access – availability, accessibility, accommodation, acceptability and affordability – as 'the degree of "fit" between the clients and the system'. Measures of these five dimensions can be closely tied to spatial distributions and linked with demographic information (Ricketts, Savitz et al. 1994: 94). This makes them useful economic and geographic tools.

A wide range of factors have been argued to impact on access, and a variety of approaches can be used to research the topic. McKinlay (1972), for example, identified six main approaches to research on the utilisation of services. These are: economic, socio-demographic, geographic, social-psychological, socio-cultural and organisational. Since McKinlay wrote in 1972, there has been significant methodological debate and empirical research relating to access and utilisation (see for example Gold and Stevens 1998, Rogers, Hassell et al. 1999, or Mohan 2001).

Health service utilisation research in New Zealand has generally used a mix of economic, socio-demographic and geographic approaches, and relied on administrative (claims-based) data sets and surveys as their main data sources. The aim has generally been to describe differences in the utilisation of primary, secondary and pharmaceutical services and to identify key barriers to access. New Zealand research has focused mainly on primary care, with little research into explaining variations in access, particularly for secondary care, between districts or over time.

New Zealand studies report variations in access to, and utilisation of, care by geographic region and major diagnostic category, by ethnicity, deprivation, and socio-demographic variables. These studies suggest a number

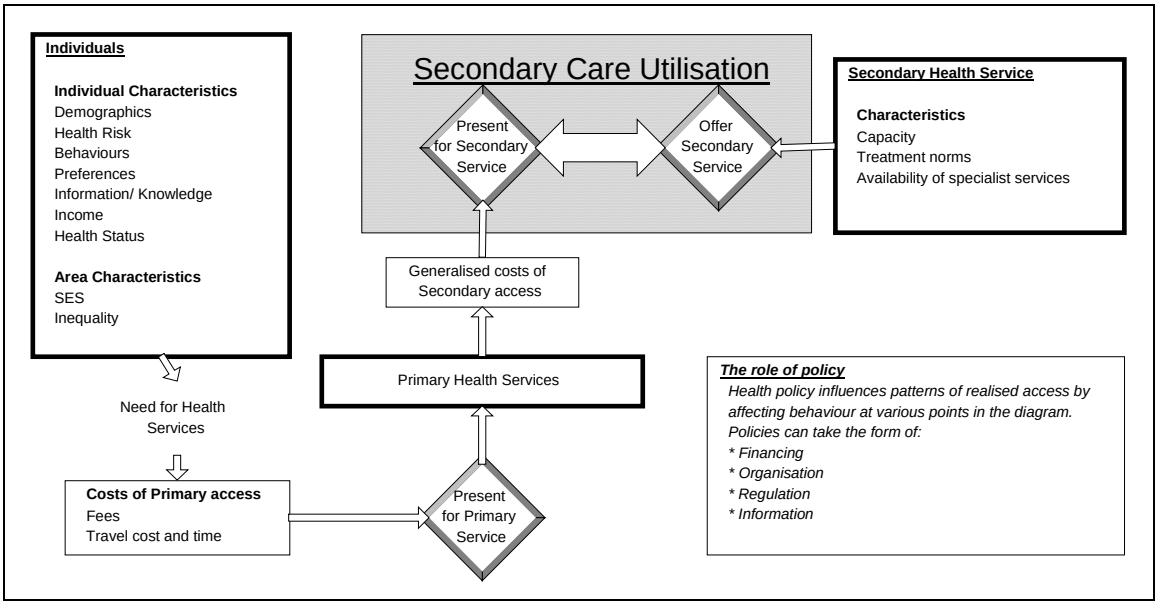
of factors may influence access, including health status, individual and household socio-economic status, area deprivation, ethnicity, primary and secondary service supply and private health insurance. Another strand of New Zealand health services research has focused on modelling service proximity. While increasingly sophisticated GIS accessibility models are being developed in New Zealand, these have not been applied in research that aims to explain trends or variations in access. As such, the links between geographic access and utilisation remain uncertain.

Study approach

Our initial interest is in the contribution of geographic and economic factors to explaining variations in utilisation in NZ. This initial study uses hospital discharge data as a measure of utilisation, straight-line distances to the hospital nearest a patient's residence as a measure of distance, and it controls for some important demand-side factors. The study's conceptual framework and methodology are briefly reviewed below.

We developed a model of access based on how patients move through the New Zealand health care system. Figure 1 illustrates key influences on utilisation. This is an organising framework for our research. The shaded box in the top centre of the diagram represents secondary care utilisation – individuals present themselves for secondary care, and are offered care by a hospital. The surrounding boxes on the diagram indicate a range of demand (to the left of the diagram) and supply (to the right) factors reflected in utilisation patterns.

Figure 1 Influences on secondary care utilisation



Our approach combines economic and geographic techniques, within a New Zealand context, relating measurable individual, population and system factors to utilisation. Studying patterns of utilisation in this manner can shed light on which dimensions of access may be important in explaining variations in access, such as socio-demography, geography or service organisation, Furthermore, the model may be extended to predict utilisation rates, allowing comparison with actual rates to highlight where inequities may exist.

Data

In order to relate discharges, local population characteristics and hospital proximity, we combine data from three sources.Our first key dataset is the National Minimum Data Set (NMDS). NMDS records summary information for all public hospital discharges, and is held by NZHIS. This dataset includes age, gender and ethnicity data. We analysed discharge data for 1996, which are geo-coded according to 1991 CAU boundaries. Data were filtered for national coding consistency according to the Ministry of Health (2000)'s Hospital Throughput report. Some MDCs and DRGs were excluded due to concerns about coding consistency expressed by NZHIS.

Our second major dataset is 1996 Census data, supplied by Statistics NZ. The Census of Population and Dwellings is a 5-yearly population survey that takes a snapshot of population and dwelling characteristics. Information used from the Census includes socio-demographic, geographic distribution and economic factors.

Ethnicity data in these two datasets is not entirely reliable. NMDS ethnicity coding procedures may differ between hospitals and it is unclear how ethnicity is determined (Pomare, Keefe-Ormsby et al. 1995). Ethnicity

data collected by different censuses is also problematic for inter-census comparisons, although this is not a significant issue for this initial analysis. Reported ethnicity statistics should be read in light of the above concerns.

Our third dataset is a hospital location dataset complied by the Public Health Intelligence, Public Health Directorate, Ministry of Health as part of a larger programme of research on geographic access to healthcare services (GASH). The initial GASH model estimates the geographical accessibility of public hospitals. It can calculate minimum travel time and distance to the closest hospital via a road network, drawing on local population information, the hospital location dataset and a national road network dataset.

Methods

To begin learning about the demand and supply factors influencing accessibility, we examine discharge rates as measures of utilisation. The two main challenges for our research are first, to derive sound estimates of key empirical relationships using limited available data; and second, to ascertain the empirical significance and impact of a range of potentially confounding effects. In this paper we get initial indications first, by a descriptive analysis and second, by regression analysis.

First, geo-coded NMDS and Census data were linked by 1996 CAUs. Patients in the hospital discharge dataset can be located to a 1991 CAU, therefore individuals who could be identified at CAU level were matched to 1996 CAUs. Differences between 1991 and 1996 CAU boundaries meant 16,391 records could not be matched as some individuals could not be identified at CAU level.

Next, we constructed hospital utilisation rates using two measures: discharge rates and discharge incidence rates. We define **discharge rate (DR)** as the number of discharges, that is, visits to hospital for in-patient treatment, per population group. The **discharge incidence rate (DIR)** is number of people who had at least one discharge per population group. If an individual has multiple discharges, the DIR will be lower than the DR.

Discharge and census data were linked to hospital proximity data using straight-line distances (SLDs). SLDs were calculated as the straight-line distance from a CAU centroid to the hospital nearest a patient's residence. The centroid position was weighted by where the population within a CAU lives (using underlying meshblock population data). This calculation overestimates access as not all operations are available at the nearest hospital. SLDs were not calculated using the hospital at which treatment was received as hospital identifier data is currently not routinely available from NZHIS. It might be argued, however, that access to a local hospital is an important precursor to referral and as such acts as a proxy suitable, although not best, for the current analysis.

The preliminary analysis describes raw relationships. We calculate univariate descriptive statistics such as distributions by MDC, DHB and sub-population groups. These statistics are not adjusted for any population characteristics, such as gender, age, or ethnicity. We later adjust for population composition using regression analysis, described below.

The second method of analysis is OLS regression of aggregated discharges on distance for people in close proximity (within 15km) to a hospital and all distances. The danger with a linear regression model is that it simply fits a straight line and can predict discharge rates below zero or greater than 1. Negative rates are meaningless and rates greater than 1 are only applicable to discharge rates where it is possible to have multiple discharges by individuals.

The third method, MLR, addresses the issue of modelling rates. Logistic regression has the advantage of producing sensible results (rates between 0 and 1), but the disadvantage of only being able to analyse discharge incidence rates (DIR), as discharge rates can be greater than 1. In this stage we take into consideration the impacts of differences between population groups or places on the relationship between utilisation and distance. We test whether any relationship found between discharge incidence and distance is due to the distribution of different population groups rather than distance.

Descriptive analysis

Basic descriptive statistics are presented below to highlight raw relationships in the linked aggregate discharge data.

The DR is higher than the DIR indicating multiple admissions.

Table 1 Descriptive statistics

	NMDS, 1996 (matched records)
Discharge records	539,443

Number of individuals	381,240
National discharge rate (DR)	15.4%
Discharge incidence rate (DIR)	10.4%

Some of the key points in the data include:

- over 55% of discharges are accounted for by 5 MDC categories
- across all MDC groups, 72% of patients only visit the hospital once for (any) in-patient treatment and only 1% of patients were admitted more than 5 times during 1996.
- DHBs with large populations have lower discharge rates (and discharge incidence rates) than DHBs with small populations
- females have higher discharge rates than males, but once discharges related to pregnancy are removed the discharge rate for women drops to 12.4% (0.1% lower than males)
- Pākeha have the highest discharge rates (15.1%) followed by Māori (14.1%) and Pacific Peoples (13.2%). Discharge incidence rates follow a similar pattern, but the differences are lower (9.9%, 9.6%, 9.4% respectively).
- discharges are proportionately larger than the population within 3.3 km of hospitals. For example, 45% of discharges occur within 5kms of a hospital, compared with 42% of the population. This trend is reversed between 3.3 km and 15 km.

Regression analysis

While simple descriptive analysis can suggest key patterns, it cannot explain whether these patterns are significant and systematic. Our second approach uses a linear regression to explain variations in utilisation. First, we use an OLS method to test the simple relationship between CAU discharge and incidence rates for distances less than 15km and for all distances. Table 1 contains the results from the OLS models. The relationship between discharge rate and incidence was tested for all CAUs (Model 1) and CAUs within 15km of a hospital (Model 2).

Both discharge and discharge incidence rates display similar results with OLS modelling. For all CAUs the relationship between unit (km) changes in distance and discharge rate or discharge incidence rate is not significant, indicating there is no simple relationship between distance and utilisation. A negative and significant relationship is found for CAUs less than 15km from nearest hospital. This suggests utilisation does decrease with distance, when we focus on people living within 15km of a hospital. The models explain little of the variation in discharge and discharge incidence rates (indicated by the small R^2 values).

Table 1 AU discharge rate/incidence against distance from hospital

OLS models	*(A) Discharge Rate*		*(B) Discharge Incidence Rate*	
	Model 1	Model 2	Model 1	Model 2
All Distances (km)	.003 (.014)		-.005 (.009)	
Distance □15km		-.355 (.002)***		-.234 (.081)***
Constant	14.851	16.683	10.616	11.784
R^2	-.0006	.0088	-.0004	.0075
Observations	1607	959	1607	959

Note: Standard errors are in parentheses. Significant at 1%(***), at 5%(**), at 10%(*).

Impact of population composition

Discharge incidence is not uniform across population groups or places. Below we analyse the impact of population composition on the relationship between distance and utilisation using a second regression technique, multivariate logistic regression (logit model). We control for population differences using sex, age group and ethnicity dummy variables and allow for places to be different using DHB dummy variables. As noted above in the Methods section, we do not analyse discharge rates using a logit model. However, as the OLS analysis does not suggest a great difference between the behaviour of the two discharge measures and their relationship with distance, reporting on only discharge incidence rates does not materially affect the results.

Table 2 reproduces the results from the OLS model 1 in Table 1B and reports the logit models which were run using all CAUs. The first logit model, model 1, includes only distance as an explanatory variable. Model 2 adds

demographic variables and model 3 includes area-based DHB variables. The relationship between discharge incidence and distance is slightly stronger (-0.01), but of a similar magnitude to the coefficient reported in Table 1B (-0.005). However, the relationship reported by the logit models 1 and 3 is significant, compared with insignificant relationship from the OLS models reported in Table 1.

Table 2 Discharge incidence rate (DIR) and distance

	OLS (DIR)	Logistic Regression (DIR)		
	Model 1	Model 1	Model 2	Model 3
All Distances (km)	-.005 (.009)	-.010 (.001)***	.002 (.002)	-.010 (.002)***
Demographics			□	□
DHBs				□
Constant	10.616			
Adj. R^2	-.0004	.000	.087	.091
Observations	1607	3655499	3655499	3655499

Note: Standard errors are in parentheses. Significant at 1%(***), at 5%(**), at 10%(*).

As individual characteristics and distance are observed at different levels there is a possibility that the logit model may understate the amount of error associated with the distance coefficient. When we control for demographics in model 2 the relationship becomes positive and weaker, with a coefficient of 0.002. However, distance redisplays a negative relationship (-0.01) with discharge incidence when we control for demographics and DHBs in model 3.

Of the three types of variables on the right-hand side of model 3, demographic characteristics explains more variation (0.087) than distance and location (0.004). When we control for population and place effects the negative relationship still holds with distance, however, it is not very strong. A 10km increase in distance from hospital results in a 0.1% decrease in discharge rate.

The logit model suggests that a patient's probability of visiting the hospital for treatment is determined by their sex, age, ethnic group, what part of the country they live in and how far they live from the hospital. For example, on average Māori are 0.9% more likely to visit a hospital for treatment compared with Pākeha whether they live in Northland or Canterbury. People living in Northland are 3.9% more likely to go to hospital compared with their counterparts living in the Canterbury DHB, irrespective of whether they are Māori or of Pākeha ethnicity. However these factors explain little overall variation in utilisation.

There is little change between discharge incidence rates for DHBs even when controlling for population characteristics. Most DHBs' discharge incidence rates change by about half a percent when controlling for population characteristics. However, the difference between Canterbury and the Bay of Plenty's incidence rates decreases by 1%, whereas the difference between Canterbury's and Southland's incidence increases by 1% when controlling for population characteristics.

The descriptive analysis highlighted that discharge incidence rates do vary across DHBs, with the metropolitan DHBs reporting lower incidence rates than the rural DHBs, which have smaller populations. The logit model confirms this in maintaining the ranking of DHBs, but the difference between DHB discharge incidence rates becomes slightly less. This implies that even when taking into account differences in population composition, DHBs with large populations (urban DHBs) exhibit lower discharge rates than smaller (rural) ones.

Discussion

This paper describes a conceptual framework for researching access in New Zealand's health system and demonstrates a method for explaining geographic variations in utilisation, examining the relationship between secondary care utilisation and distance to care.

A key goal was methodological. Drawing on economic and geographic approaches we wanted to establish the importance of individual, population and system factors affecting utilisation, while statistically controlling for a range of factors that may cloud the relationships. We demonstrated that it is feasible to link up national datasets to examine the relationships between secondary care utilisation, patient demographic profiles, proximity and population distribution. This approach can be used to examine a fuller range of access dimensions and to make comparisons across a range of services, population groups and time.

A second goal was to test the feasibility of this methodology using a simple hypothesis about the relationship between distance and access. We began by describing patterns of utilisation by MDC group, DHB, population

group and distance. Simple descriptive patterns, however, are not sufficient to establish a factor's significance or its contribution to explaining variations in utilisation. A major advantage in our approach is that regression techniques can be used to investigate the statistical significance of the patterns observed. It allows us to control for a wider range of possible confounders than has occurred to date, such as differences in patient characteristics and location, using DHBs as proxies, to give sounder explanations of the roles of different factors affecting utilisation. These explanations can contribute to understanding why access problems exist and may contribute to reducing access inequities.

In this preliminary study we used a simple measure of proximity. Advances in GIS methodology and technical capabilities allow increasingly sophisticated use of data sources and appropriate measures of travel time and distance. The analysis can also be extended by using alternative geographic boundaries and provider locations. For example, incorporating a dataset on GP locations would allow the analysis to control for distance to a GP.

The approach developed in this study may be adapted for routine surveillance and monitoring of access across DHBs and equity of access for target population groups. In addition, comparative analysis of access may highlight areas for further investigation and provide feedback for policy development and implementation.

Paper download

The paper underpinning the presentation is available on the Health Services Research Centre: http://www.vuw.ac.nz/hsrc/Discussion%20Paper%207.pdf.

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