Department of Health, Social Services and Public Safety

Project Support Analysis Branch

Estimates of Hospital Catchment Populations for Inpatient Activity in N Ireland

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Introduction

This paper uses provisional 2001/02 data from the Hospital Inpatients System Database to estimate the catchment population relating a range of specialties in Northern Ireland's acute hospitals. Day case activity is included in this analysis.

The Hospital Inpatients System Database is maintained by the Department's Regional Information Branch and records details of each inpatient episode in N Ireland. The information in the database is provided by the hospitals themselves and thus the direct catchment populations for each specialty are a reflection of each hospital's classification of its inpatient activity.

Definition of Catchment Population

These calculations use the following definition of catchment populations:

> For a given hospital or unit and for a particular specialty the catchment population is that group of persons who would attend the hospital or unit were they to require treatment under that specialty.

It is significant to note that the language employed in this definition alludes to potential. This is an important concept in catchment populations, because catchment populations are more than mere counts of users: they are estimates of the number of potential users. It is also important to note that there is no such thing as a single catchment population for a hospital, ie there are separate catchment populations for each specialty.

Various methods for estimating catchment populations exist, and a useful summary appears in a paper by Senn and Samson published in *The Statistician*, Vol 31, No. 1,1982. Of the five methods they considered, three methods (the 'RAWP', 'Gandy' and 'Cottrell' methods) required the use of a 'resident population' figure which Senn and Sampson considered may be an inappropriate starting point, given that the whole purpose of the exercise is to estimate populations. A fourth method, the 'Median Line' method was dismissed as being 'vastly inferior', which left Bailey's method.

Senn and Samson concluded that Bailey's method should be used whenever possible, and that small areas rather than large areas are preferable as the basis of calculation.

Having considered the limitations of all possible approaches, this paper uses Bailey's Method. This method has the advantage of being based on actual observed flows – a basis which other theoretical models do not have.

Bailey's Method

The computation is carried out as follows:

If we imagine an area Y with population size n which sends m_1 cases (for a particular specialty) in a given period to hospital X and m_2 cases elsewhere, then the contribution that Y makes to the catchment population of hospital X is estimated to be

$$a = nm_1 / (m_1+m_2)$$

If C is the catchment population of hospital X then

C = Ó a

For example, if Ards LGD has a population of 70,600 and sends 4 cases in a year to Altnagelvin Hospital and 8895 cases elsewhere, then the contribution that Ards LGD makes to the catchment population of Altnagelvin Hospital is estimated to be

$$a = 70600\ (4) / (4+ 8895) = 31.73$$

This process is repeated for each LGD in respect of Altnagelvin Hospital, ie

C = Ó a

to estimate the catchment population for that hospital.

This is algebraically equivalent to saying that 4 out of 8899 (ie 0.0449%) patients from Ards LGD attend Altnagelvin Hospital, therefore 0.0449% of the Ards population can be expected to behave likewise. Using observed behaviour based on a few cases to generalise about the expected behaviour of the whole population is a key assumption in the Bailey method. This is a weakness of the approach. For example, the four cases in the worked example above could have been visitors to the Altnagelvin area and, for example, might be the victims of a road traffic accident. If this were the case it would be questionable whether this random incident is a sound basis from which to predict the hospital admission behaviour of all of the people of Ards LGD. Whilst we do not know whether the observed admission behaviour of these four cases is due to a random event or is part of an established 'flow', it is reasonable to assume that the totality of all such admission behaviour in Northern Ireland will contain a mixture of both types of activity, and that each hospital's catchment population will contain elements of both. Because all catchments will include random activity, the effects will, to some extent, cancel out.

As part of the exercise, the above iterations were repeated for all acute hospitals in N Ireland.

Data

The data used in this exercise is provisional 2001/02 data from the Hospital Inpatients Database. This was provided in summary form by the Department's Regional Information Branch. For each hospital and for each specialty being studied, the dataset provided counts of the number of inpatients from each electoral ward. The population data used was the NI ward level population estimates (for the year 2000), downloaded from http://www.nisra.gov.uk/whatsnew/dep/index.html. It would now be possible to update the analysis using the recently published 2001 mid-year population estimates based on the 2001 census.

Analysis

Analysis was done with the aid of an Excel spreadsheet.

The first stage was to arrange the data in the spreadsheet as shown below:

Provisional Data 2001 - 2002 - All Cases on selected Specialties by District, Ward and Hospital

				BELFAST CITY					
District	Ward	Ward Code	POP^{N} (Noble)	General Medicine	Gastroenterology	Haematology Clinical	Cardiology	Dermatology	Thoracic Medicine
ANTRIM	Aldergrove	101	4022	5	2	0	2	1	3
ANTRIM	Balloo	102	1599	2	0	0	4	0	0
ANTRIM	Ballycraigy	103	1887	0	1	0	2	0	1
ANTRIM	Clady	104	2659	10	4	7	2	3	0
ANTRIM	Cranfield	105	2665	2	0	1	0	0	0
ANTRIM	Crumlin	106	4285	6	2	5	4	1	3
ANTRIM	Drumanaway	107	2248	0	0	0	1	3	0
ANTRIM	Fountain Hill	108	1983	0	1	0	1	0	1
ANTRIM	Greystone	109	2404	1	2	8	4	0	1
ANTRIM	Massereene	110	4044	2	0	0	3	0	1
ANTRIM	Newpark	111	1889	0	1	0	1	0	0
ANTRIM	Randalstown	112	2944	5	0	0	0	16	0
ANTRIM	Rathenraw	113	1396	0	0	1	0	0	0
ANTRIM	Springfarm	114	3779	0	0	0	3	0	6
ANTRIM	Steeple	115	1809	0	2	3	2	0	1
ANTRIM	Stiles	116	2543	2	2	0	2	0	3
ANTRIM	Tardree	117	2678	2	0	0	1	3	3
ANTRIM	Templepatrick	118	3181	3	1	0	2	47	3
ANTRIM	Toome	119	2711	0	0	0	3	0	0
ARDS	Ballygowan	201	4104	24	2	8	4	38	3
ARDS	Ballywalter	202	3616	3	2	5	22	22	11
ARDS	Bradshaws Brae	203	2904	3	0	0	12	21	1
ARDS	Central	204	2354	3	0	17	12	0	5
ARDS	Comber North	205	2796	2	3	0	15	1	1
ARDS	Comber South	206	3526	1	2	0	19	2	0
ARDS	Comber West	207	3639	1	1	7	8	1	4
ARDS	Donaghadee North	208	2646	4	0	12	22	1	0
ARDS	Donaghadee South	209	3649	2	0	7	16	0	3

The rows of the spreadsheet correspond to electoral wards, while the columns correspond to specialties (nested within hospitals). Thus, for example, General Medicine activity can be found in the following columns: E, X, AA, …, …, ES, EU, EZ.

For each row (electoral ward) of the database, the number of inpatients in each specialty was separately totalled. Thus the number of patients from Antrim Aldergrove admitted for General Medicine was the sum of all of the cell counts for that row, ie

E6+X6+AA6+…,…,+ES6+EU6+EZ6 which totalled to 196.

Given that 5 of these 196 General Medicine inpatients from Antrim Aldergrove attended Belfast City Hospital, the formula estimates that potentially

$$(5/196) \times 4022 = 102.6$$

of Antrim Aldergrove's population would attend Belfast City Hospital as General Medicine inpatients. When this process is repeated for all 566 electoral wards, the estimates are summed to give an estimated catchment population for Belfast City Hospital. Likewise, the process is repeated for all hospitals (and for all specialties). This process works well for specialties which attract large numbers of patients. A problem arises when there is a low volume specialty, and one or more electoral wards do not provide any patients.

A case in point in this study arose with Cardiac Surgery. When the calculations were performed on the spreadsheet, and the catchment population for the Royal Victoria Hospital (the only location where this work is carried out) was estimated, the estimated catchment population was around 1.24 million. This is not what was expected, given that the catchment population should have been the entire Northern Ireland population.

The reason for this anomaly was that around 180 wards (with a collective population of around 450,000) did not send any patients to hospital for cardiac surgery in 2001/02. Because the formula uses the proportions of patients going to each hospital to estimate proportions at the electoral ward population level likely to attend, if no patients originate from a ward, the formula will extrapolate this to 0% of the ward's population.

However, because catchment populations allude to potential users, it is incorrect to assume that if nobody from a ward attends hospital, that ward's population does not form part of a hospital's catchment population.

For specialties with only one point of delivery, the solution is a straightforward transfer of the entire ward population to that catchment population. For specialties with several points of delivery, the ward's population has to be apportioned in some way. Two options were investigated: the first was to assume that the population in a ward would attend the same hospitals in the same proportions as the population of neighbouring wards, the second option was to assume that the population of a ward would attend hospitals in the same proportions as all wards in the LGD.

Option 1 had several problems, not least how to define 'neighbouring' wards – are a ward's 'neighbours' all those wards that share a boundary with it, is it the 'most similar' adjacent ward, is it all wards within a certain radius? It was decided to objectively identify 'neighbours' by calculating the road travel time (using the Simplified Modelling of Spatial Systems [SMOSS] software developed by Dr Hindle of the University of Lancaster) from each enumeration district to the centroid of each ward. These times were then weighted by the population to give an average road time from ward to ward. A ward's 'neighbours' were then defined to be the five wards with the lowest average road travel time.

Option 2 – which assumed that wards exhibited 'regional behaviour' was chosen instead on the grounds of computational simplicity. This meant that all patient destinations in an LGD were used to estimate 'average behaviour' for the LGD and this pattern of admission was then assumed to be prevalent in each constituent ward. In this way, wards which provided no patients to any hospitals were assumed to provide patients to hospitals in identical proportions to the average for the LGD.

Note: A comparison was made of the above two approaches, which involved estimating the catchment populations for the anaesthetics specialty in acute hospitals by the 'nearest neighbour' and 'regional behaviour ' methods. The two methods produced very similar results for hospitals with large catchments: the largest variation in catchment size was 3.7% for the Royal Belfast Hospital for Sick Children, with most of the catchments for other hospitals varying by less than one percent. Hospitals with small catchment populations for anaesthetics (<2000) showed higher percentage variation due to the small numbers involved.

Results

Full results for all hospitals by specialties appear in Appendix 1. For some specialties (Clinical Genetics, Paediatric Neurology, Palliative Medicine, Haematology – Pathology), there were so many empty cells in the spreadsheet, it was deemed that there was too little data on which to produce an estimate.

Conclusion

This exercise estimates catchment populations for inpatient activity, based on the Bailey Method of calculation and using official DHSSPS data.

Due to the fact that datasets containing the addresses of A&E users and outpatients is not held centrally, it has not been possible to model this activity. The findings in this paper therefore do not represent the totality of hospital activity.

Analysis such as this cannot be used to predict catchment populations for hypothetical configurations of hospitals, services or capacity because it is reliant on statistics which describe observed patterns of behaviour.