Variations in the utilisation of cardiology services: another example of the inverse care law

Geographical Area covered: Sheffield
Focus: Case studies focusing on subdistrict variation in health outcome

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Editorial comments on how case study is linked to improving health outcomes: (also published in Volume 1)
Payne and Saul describe a population-based assessment of health outcomes which highlighted marked variations in coronary heart disease mortality within Sheffield. Further investigation showed that utilisation of coronary artery revascularisation services did not correspond with need and seemed to exhibit the Inverse Care Law. These findings prompt the need for further work to ensure that the use of, and access to, facilities ensures that access to health care is targeted where it will have the greatest effect.

Abstract (also published in Volume 1)
Objectives: To explore the relationship between the utilisation rate for coronary artery revascularisation and the prevalence of angina in order to assess whether the use of health services reflects the need for health care.
Design: The prevalence of angina symptoms was determined using a modified form of the WHO (Rose) angina questions administered by a postal questionnaire survey with a sample size of 16,750. Data on coronary heart disease mortality and hospital admissions, including the uptake of coronary artery revascularisation, were compared with the prevalence of angina symptoms at electoral ward level. In addition, questionnaire results were linked to health event data at individual respondent level.
Setting: The study took place between 1994 and 1996 in an urban Health Authority with population of 530,000.
Main outcome measures: Relationship between variables examined by calculating Pearson's product moment correlation coefficients.
Results: Overall, 4.0% (95% confidence interval 3.7 - 4.4%) of the population aged 18-94 experienced symptoms of grade 2 angina. There was a wide variation in the prevalence of angina symptoms between electoral wards, and a strong positive relation ($r = +0.79, p < 0.001$) with Townsend deprivation score. A similar relationship was seen for coronary heart disease mortality, but the correlation between admission rates and Townsend deprivation score was less marked ($r = +0.47, p < 0.01$). No relationship was found between coronary artery revascularisation rates and Townsend deprivation score. An inverse relationship ($r = -0.67, p < 0.001$) was found when the ratio of coronary artery revascularisation to the number experiencing grade 2 angina symptoms was plotted against the Townsend deprivation score. The most deprived wards had only about half the number of coronary artery revascularisations per head of population estimated to have angina than did the more affluent wards. Whilst 11% of individual survey respondents with angina symptoms from the 10 most affluent wards had had a coronary angiogram, only 4% of those with symptoms for the 10 least affluent wards had been thus investigated ($\chi^2 = 4.96, p =0.026$).

These results were presented to Sheffield cardiologists in 1996 and steps were agreed to try to redress the apparent inequalities, including, for example, informing GPs about referral criteria for patients with angina.

Conclusions: A population-based assessment of health outcomes had highlighted marked variations
in coronary heart disease mortality within the District. Further investigation showed that utilisation of coronary artery revascularisation services did not correspond with need and seemed to exhibit the Inverse Care Law. These findings prompt the need for further work to ensure that the use of, and access to, facilities ensures that access to health care is targeted where it will have the greatest effect, particularly if it is planned to increase the purchasing of coronary artery revascularisation services.

**Introduction:**

**Why this clinical area was chosen:**

Tudor Hart (1971) enunciated the sad fact that "the availability of good medical care tends to vary inversely with the need for it in the population served"; often summarised as the Inverse Care Law. The Variations sub-group of the Chief Medical Officer’s Health of the Nation working group (1995) addressing health inequalities have suggested Health Authorities should carry out "equity audits" in order to determine whether health care resources are being utilised in accordance with need as this is felt to be a useful first step in reversing the Inverse Care Law where it is found to exist.

In the treatment of angina, Health Authorities have been urged by the Working Group of the British Cardiac Society (1994) to increase the availability of coronary artery revascularisation treatment such as coronary artery bypass graft (CABG) and angioplasty. There is, however, marked national and local variation in treatment rates (Clinical Standards Advisory Group, 1993; Ben-Shlomo and Chaturvedi, 1995). Whilst some studies have shown poor access to services among residents of high deprivation (Majeed et al. 1994), others have found no such relationship (Kee et al. 1993). In general, utilisation of coronary artery revascularisation treatment for angina will be influenced by the following factors.

- **Need** - epidemiology of disease which, even after standardising for age/structure differences, varies substantially from place to place, both at national and local levels.
- **Supply** - the availability of cardiologists and centres carrying out revascularisation procedures has been shown by several authors to be a substantially important predictor of utilisation (Clinical Standards Advisory Group, 1993; Wennberg et al. 1995).
- **Demand** - which in turn is affected by: patients’ consultation thresholds; general practitioners’ referral thresholds; and cardiologists’ referral and intervention thresholds.

In the study reported here, we have examined the prevalence of angina at small area level within a city, Sheffield, no part of which is more than 20 kilometres from a major teaching hospital centre carrying out interventional cardiology. We report that the ratio of coronary artery revascularisation rates to angina-like symptom prevalence varies substantially across the city and is inversely proportional to deprivation.

**Further information that was required:**

Sheffield has a population of around 530,000 living in both rural and urban areas. It has 29 electoral wards ranging in size from 12,400 to 31,800 residents. The black and ethnic minority population accounts for 5% of the total - a similar proportion to England and Wales as a whole. The unemployment rate (economically inactive population aged 16-59/64) was 12.4% at the last census. Both unemployment rates, and composite measures of deprivation such as Townsend and Jarman scores, reveal very marked differences between differing parts of Sheffield.

Sheffield as a whole has a higher mortality rate from coronary heart disease than England and Wales. Over the period 1988-92 the standardised mortality ratio was 109% for all age mortality, but even higher at 118% for premature deaths (age 35-64) from this cause.

Specialist cardiological investigation and treatment is carried out at the Northern General Hospital located north east of the city centre but closest to some of the electoral wards with the highest coronary heart disease standardised mortality ratios. This hospital also provides specialist cardiological services to the surrounding districts in South Yorkshire and North Derbyshire, thus serving a population of around 1.5 million. The other large acute hospital in Sheffield (the Royal Hallamshire Hospital) does not carry out either coronary angiography or coronary artery revascularisation, but patients seen first there are referred to the Northern General Hospital for such investigation and treatment. During 1994/5 the CABG rate was 400 per million population per annum, while the angioplasty rate was 104 per million.
Determining the prevalence of angina

After ethical approval had been obtained, the Health Authority's population register was used to generate an age/sex stratified random sample of Sheffield residents registered with Sheffield general practitioners. The stratification was by six age/sex bands, male/female, 18-34, 35-54, 55-94. A postal questionnaire seeking to determine the prevalence of a range of common symptoms, was sent to this sample of 16,750 Sheffield residents in March 1994.

The sample was also stratified at the electoral ward level, such that the prevalence of the various conditions studied could be estimated with reasonable confidence limits at each of the 29 electoral wards in Sheffield.

The World Health Organisation Angina questions (Rose et al. 1977), in a slightly simplified form, were used to assess the prevalence of angina symptoms amongst the survey population. Up to two reminders (one full questionnaire and one postcard) were sent to those who failed to respond to the first mailing.

By preserving a unique patient number, questionnaire data from individual respondents could be directly linked with health event data such as hospital admissions and procedures.

Health event and census data

The Health Authority's database was used to examine relevant hospital admission data both at electoral ward level and for individual survey respondents. At electoral ward level, overall admission rates (i.e. including both emergency and elective) for coronary heart disease (ICD9 410-414 - World Health Organisation 1977) were calculated, as were admission rates for CABG (K40-K47) and angioplasty (K49 and K50.1 - Office of Population Censuses and Surveys 1990). At individual level, particular attention was paid to admissions for angiography (K63-K65), CABG and angioplasty during the period 1st April 1991 to 31st December 1995, i.e. a time period just before and after the survey. No data were obtained about use of the private sector for these investigations and procedures. The 1991 Census small area statistics were used to calculate Townsend deprivation scores (Townsend 1987) for each of the 29 electoral wards in Sheffield.

Data handling and analysis

Survey data were analysed with EpiInfo (Dean et al. 1990) Where appropriate, individual ward data were directly standardised using the population of England and Wales as the reference. Data were plotted as scatter plots and Pearson's Product Moment correlation coefficients were calculated.

Of the 16,750 questionnaires sent out a total of 12,240 (73%) were completed and returned. After excluding a further 1,160 that were returned without reaching the person for whom they were intended, the response rate rises to 79%. For Sheffield as a whole the prevalence of angina symptoms by age/sex and by grade is shown in Table 1.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age band</th>
<th>Grade 1</th>
<th>Grade 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>18-34</td>
<td>4.3%</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>35-54</td>
<td>5.8%</td>
<td>2.6%</td>
</tr>
<tr>
<td></td>
<td>55-94</td>
<td>13.0%</td>
<td>8.7%</td>
</tr>
<tr>
<td>Female</td>
<td>18-34</td>
<td>5.9%</td>
<td>1.1%</td>
</tr>
<tr>
<td></td>
<td>35-54</td>
<td>6.4%</td>
<td>2.3%</td>
</tr>
<tr>
<td></td>
<td>55-94</td>
<td>11.8%</td>
<td>6.4%</td>
</tr>
</tbody>
</table>

Overall, 12.8% (95% confidence interval 12.2% - 13.3%) of the population experienced symptoms of pain or discomfort in the chest of which 8.2% (7.7% - 8.7%) were grade 1 (occurring when walking uphill or upstairs) and 4.0% (3.7% - 4.4%) were grade 2 (when walking on the flat). For a further 0.6% the grade of angina was not determinable.

Main findings

There was a wide variation in the age-standardised prevalence of symptoms of angina between electoral wards - it ranged from under 2% in some to over 6% in others. Figure 1 shows that there is a strong positive relation ($r = +0.79$, $p < 0.001$) between the Townsend score of the electoral ward and the prevalence of grade 2 angina symptoms.
Figure 1: Angina symptom prevalence compared with Townsend deprivation score

Figure 2 shows that a similar relationship is seen when mortality from coronary heart disease is plotted against Townsend Score. Again, there is a very wide variation in the mortality rates between electoral wards and mortality is strongly and significantly correlated with Townsend Score ($r = 0.78$, $p < 0.001$).

Figure 2: Coronary heart disease mortality (standardised mortality ratio 1988/92 ages 35-64) compared with Townsend deprivation score.
Admission rates for coronary heart disease are plotted against Townsend Score in figure 3. The range of variation between electoral wards is now less than that of the range of angina symptoms or of coronary heart disease mortality, varying little more than two-fold between the highest and lowest electoral wards. There is still a significant correlation between admission rates and Townsend Score ($r = +0.47$, $p < 0.01$) but it is now less marked than was seen in respect of angina symptom prevalence or coronary heart disease mortality. Figure 4, however, shows there is no relationship at all between the coronary artery revascularisation rates (angioplasty or CABGs) and Townsend score.

**Figure 3:** Coronary heart disease admission rate (1992/3 to 1994/5) compared with Townsend deprivation score.
Figure 4: Coronary artery revascularisation rates (1992/3 to 1994/5) compared with Townsend deprivation score.
In order to determine whether utilisation of coronary artery revascularisation was uniformly related to need, the ratio of angioplasties/CABGs to the number in the electoral ward estimated to have angina was calculated. This index is plotted against Townsend score in figure 5. There is a marked variation between electoral wards in the revascularisation treatment to angina ratio. Now it is seen that the most deprived wards have only about half the numbers of interventional treatments per head of population estimated to have angina than do the more affluent wards ($r = -0.67$, $p < 0.001$).

Confirming this was the finding that there was a similar inverse relationship at electoral ward level between revascularisations per premature CHD death and Townsend score ($r = -0.55$, $p < 0.01$) as well as between revascularisations per myocardial infarction and Townsend score ($r = -0.47$, $p < 0.01$).

**Figure 5:** Angioplasty/CABG (1992/3 to 1994/5) per number with angina symptoms compared with Townsend deprivation score.
Individual survey results from respondents who have grade 2 angina symptoms were linked to health event data to determine whether they had been admitted to hospital for angiography, angioplasty or CABG in the two years before and one year after the date of the survey. The annual angiography rate was found to be almost 20 times higher in those with survey identified angina (19.7/1000 population) compared with the general population rate (1.0/1000 population). However, table 2 shows that there was substantial difference between the more affluent and less affluent electoral wards in terms of the proportion of angina positive survey respondents that had had interventional cardiology. In the ten most affluent wards, 11.2% had had angiography compared with 4.2% in the ten most deprived electoral wards ($\chi^2 = 4.96, p = 0.026$).

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Number</th>
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<tbody>
<tr>
<td>Ten most deprived wards</td>
<td>4.2%</td>
</tr>
<tr>
<td>Ten most affluent wards</td>
<td>11.2%</td>
</tr>
</tbody>
</table>

When the cohort with survey identified angina was considered by age group, 6.9% (22/321) of those aged under 70 years had had angiography compared with only 1.2% (2/170) of those aged 70 and over ($\chi^2 = 6.53, p = 0.01$). Selecting elderly patients for angiography is more complex than selecting younger patients, due partly to the increased likelihood of co-existing morbidities compromising recovery or survival. However, it has been argued that symptomatic benefit is similar for younger and older patients and that earlier referral and investigation might yield a population with lower operative risk (Elder et al. 1991).

The results presented here show that there is a large local variation in both coronary heart disease mortality and in the prevalence of angina as determined by a population survey. Both mortality and angina symptom prevalence are strongly correlated with material deprivation as estimated by the Townsend score at electoral ward level. Morbidity, calculated as the prevalence of angina symptoms, shows therefore, a similar relationship as mortality.
However, use of services is not commensurate with need and seems indeed to exhibit the inverse care law, even though the supply of care is the same.

**Data validity studies:**

When carrying out electoral-ward based analysis, the possibility of ecological fallacy must be considered. It may not be valid to assume that relationships found at small area level exist at the level of the individuals who make up those areas. We considered, therefore, data at both small area and individual level.

The data on coronary artery revascularisation treatment rates refer only to procedures undertaken within the NHS, and private sector activity may add another 10 to 20 percent to these figures (Audit Commission 1990). However, given that private sector activity rates are likely to be higher for more affluent electoral wards, the differences in use in relation to need for interventional cardiology services between the affluent and deprived populations may be even greater than described above.

Electoral ward survey response rates varied between 63% and 88%, with the affluent wards tending to have the highest response rates, and this might have influenced the results. However, all but five of the 29 wards had a response rate of over 70%. In addition, the lower response rates in deprived electoral wards are only of concern if they result in the deprived respondents being less representative of the deprived population than affluent respondents are of the affluent population, and there is no evidence that such a response bias exists.

It must also be acknowledged that problems have been identified regarding the utility of the WHO (Rose) angina questionnaire, particularly regarding its specificity in females (Garber et al. 1992). However, although this may have implications for the absolute values of symptoms of grade 2 angina reported here, there is no evidence that specificity and sensitivity rates are likely to vary according to level of deprivation and so any impact on the comparison between affluent and deprived populations is likely to be insignificant. Moreover, the relationship shown between coronary heart disease mortality and deprivation strongly reinforces our finding with respect to the distribution of angina symptoms.

**Summary findings from initial work:**

**Changes which were made:**

The results have been presented to the various groups within Sheffield including, particularly, the Health Authority and the relevant consultant cardiologists. This presentation was in the context of one of their regular research/audit meetings and it generated substantial interest and debate. They felt strongly that their decision to carry out angiography and subsequent revascularisation if indicated was based only on the nature and extent of the disease. There were no systematic data available to suggest that their revascularisation thresholds were different for patients who were from less affluent wards, or were smokers, or between males and females.

With the latter we have agreed to set up some case scenarios for general practitioners in order to ensure that people with angina are referred for assessment with a view to coronary artery revascularisation whenever appropriate. This, essentially is to address the potential problem of referral thresholds perhaps being different and disadvantaging those from more deprived parts of Sheffield. It is intended to discuss the results with GPs particularly those working in these areas and seek their views on how to redress any inequalities in service provision. Further work could include, for example, interviewing patients with angina who present late, and increasing the awareness of angina in deprived areas.

**How changes will be monitored:**

These data have been (or will be) presented and discussed widely with clinicians working in primary, secondary and tertiary care in Sheffield. Carrying out an audit of referral of angina patients, particularly seeking to redress this apparent inequity has been suggested. As cardiology services are expanded, the original work will need to be repeated to ensure that those in the less affluent parts of the city have indeed been targeted.

While these are process not outcome measures, it has been argued that these are particularly important when monitoring services at local level (Mant and Hicks 1995). In addition, if, as in this
case, there is clear evidence of the effectiveness of the interventions described, the measurement of process is an acceptable proxy for outcome.

**Resource Implication:**

Internally a research officer from the Department of Public Health has spent a substantial amount of time on this work and around £16,000 was required to carry out the survey itself. It has, however, supplied data for use in a number of areas, not just those relating to angina and coronary artery revascularisation.

It is the Health Authority's intention, provided development resources allow, to continue to expand its provision of coronary artery revascularisation. It is thus the intention for this funding to allow the necessary increase in provision in order for the rates in deprived areas to be brought up to those in the more affluent. This would approximately increase the present revascularisation rate of 500 per million per annum to around 700 per million, a figure closer to that recommended (Working group of the British Cardiac Society, 1994). However, the extra cost to Sheffield would be around £500,000 per annum which would take up a very substantial proportion of any funds we might expect to receive for all new developments in any one year.

**Practical lessons learnt:**

The main practical lesson learned was that it is important to carry out assessments of the likely need for services in ways that are independent of current use. Only such assessments allow an adequate analysis of whether inequity in service provision is likely to be occurring. The cardiologists were particularly interested in this information when it related to their local population and this was important in recruiting their interest in the issue.

**Conclusion:**

A population-based assessment of health outcomes had highlighted marked variations in coronary heart disease mortality within the District. Further investigation showed that utilisation of coronary artery revascularisation services did not correspond with need and seemed to exhibit the Inverse Care Law. These findings prompt the need for further work to ensure that the use of, and access to, facilities ensures that access to health care is targeted where it will have the greatest effect, particularly if it is planned to increase the purchasing of coronary artery revascularisation services.

**References:**

A) Variations in the utilisation of cardiology services: another example of the inverse care law


Organisational Context:

The first study described here was undertaken as a result of a special research project funded by non-recurrent funds in the Department of Public Health as part of its continued interest in the impact of deprivation on health in Sheffield. The authors had previous experience in the use of the survey methods described.

The second project was a result of the North Trent Renal Purchasers Group’s interest in finding out more about the outcomes of a service which needs to consume increasing amounts of resources each year just to keep acceptance rates static, and still more to extend the treatment to more elderly groups of the population. This latter project was led by a senior registrar in Public Health Medicine and was made possible by a grant from the Trent Research and Development Programme. Again the author had special experience, having worked for some years as a clinician on the renal unit.

Neither, therefore, was part of a systematic programme using health outcome measures in other clinical areas. It is our view that the use of outcome indicators is important, but can be time and resource consuming. Sheffield Health Authority has substantial familiarity with routine data and good access to it. However, while the wider use of more simple or less time consuming indicator methodology can be of value we believe, like others, that it is important to avoid over-interpreting the results of such work, irrespective of whether it is carried out at local or national level. Thus, for example, the CABG rate per head of population is not a good national indicator given that there is clear evidence that the prevalence of the disease the intervention is designed to treat is so different between different parts of the country. Moreover, at Health Authority level an ‘acceptable’ CABG rate could disguise substantial inequalities in utilisation between different areas within the District. This caution with respect to simplistic measures ought to be an important part of a Health Authority’s approach to the use of population health indicators. Finally, it is important to work for a collaborative approach with clinicians in respect of developing outcome measures and in attempting to change clinical behaviour. There is no magic solution to carrying this out - rather one needs time and commitment to carry out detailed work on specific topics such as, for example, the renal outcome measure described here, or on aspirin prescribing as has been demonstrated in the FACTS project (Framework for Appropriate Care Throughout Sheffield).