Does increased investment in coronary angiography and revascularisation reduce socioeconomic inequalities in utilisation?

C J Manson-Siddle, M B Robinson

Abstract

Objectives—To investigate whether additional resources for tertiary cardiology services, aimed at increasing coronary angiography and revascularisation rates, can improve socioeconomic equity of utilisation.

Design—Cross sectional ecological study, using the Super Profile classification of enumeration districts and ischaemic heart disease (IHD) standardised mortality ratios (SMR) as a proxy for need. The degree of equity before the provision of extra resources was determined using data for April 1992 to March 1994, and the corresponding picture after, using data for April 1994 to March 1996.

Setting—South Humberside (United Health - Grimsby and Scunthorpe Health Authority, a district of the former Yorkshire Region, before the April 1996 boundary changes).

Subjects—Patients with a primary diagnosis of IHD aged ≥25 years who underwent investigation by angiography, or treatment by coronary artery bypass grafting or percutaneous transluminal coronary angioplasty, as a primary procedure.

Main results—In 1992/4, before concerted intervention, both investigation and revascularisation rates, although increasing, were low in Grimsby and Scunthorpe district compared with most other districts in the Yorkshire Region. Also, there was a decreasing trend across Super Profile Lifestyle groups from the Affluent Achievers to the Have-Nots despite a two-fold increase in SMRs indicating the greater need of the more deprived. After appointing a consultant general physician with an interest in cardiology in the Scunthorpe district general hospital in 1994; arranging for both the Grimsby physician and the Scunthorpe physician to undertake angiography at a neighbouring district tertiary cardiology centre in 1995; together with significant additional health authority investment in cardiac procedures in 1995/6, district rates increased considerably, (a 41% increase in investigation and a 47% increase in revascularisation rates). Also, after additional resource input began, the trend for angiographies across socioeconomic groups clearly became more equitable, although increased equity for revascularisations is less apparent.

Conclusion—Early indications are that additional resources for tertiary cardiology may have reduced socioeconomic inequities in angiography, without being specifically targeted at the needier, more deprived groups. Improvement in socioeconomic equity of utilisation of revascularisation is not yet clear, although data for April 1996 to March 1998 (after a lengthier intervention period) may confirm improved equity. Should this not be so, it might be necessary to specifically target resources to the deprived to increase equity in revascularisation.

The socioeconomically disadvantaged have been shown both nationally and locally to experience a greater burden of coronary heart disease mortality than the privileged. Similarly, they have also been shown to experience more ill health. Investigation by coronary angiography followed, where appropriate, by revascularisation using coronary artery bypass grafting (CABG) or percutaneous transluminal coronary angioplasty (PTCA), has been shown to be effective both in prolonging the life of those with extensive coronary disease at moderate to high risk, and in improving the quality of life. Given the founding principle of an equitable NHS, and that clinical effectiveness is evident, it would be expected that the socioeconomically disadvantaged would therefore also experience more coronary angiographies and CABGs/PTCAs—that is, equal utilisation for equal need.

Previously, the medical literature examining the relation between socioeconomic status and coronary angiography/revascularisation rates, had shown contradictory results, possibly attributable in part to the different methodologies used. Using Super Profile analysis, we confirmed socioeconomic inequity in both coronary angiography and revascularisation within the former Yorkshire Region in the period 1992–1994.

The Super Profile methodology uses multivariate techniques to combine 120 census variables that indicate deprivation—that is, a multidimensional view to more accurately reflect the multidimensional nature of socioeconomic circumstance. It uses enumeration districts (EDs), the smallest geographical area for which the data are available, to limit the scope for...
**Table 2 SMRs and average annual (1992–4) age-sex standardised investigation and revascularisation rates/million with 95% confidence intervals, aged 25 years and over**

<table>
<thead>
<tr>
<th>Geographical area</th>
<th>CHD SMR</th>
<th>District rates</th>
<th>I Affluent Achievers rates</th>
<th>X Have-Nots rates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Angiography rates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leeds</td>
<td>100</td>
<td>2643 (2532, 2754)</td>
<td>1755 (1470, 2040)</td>
<td>3323 (2929, 3717)</td>
</tr>
<tr>
<td>United Health</td>
<td>119</td>
<td>1272 (1166, 1377)</td>
<td>1489 (1082, 1895)</td>
<td>1205 (851, 1558)</td>
</tr>
<tr>
<td>West Yorkshire</td>
<td>121</td>
<td>1296 (1208, 1384)</td>
<td>1137 (849, 1424)</td>
<td>1533 (1146, 1920)</td>
</tr>
<tr>
<td>Bradford</td>
<td>113</td>
<td>963 (872, 1054)</td>
<td>716 (462, 970)</td>
<td>1159 (895, 1481)</td>
</tr>
<tr>
<td>Wakefield</td>
<td>121</td>
<td>1902 (1788, 2007)</td>
<td>1302 (818, 1786)</td>
<td>2063 (1521, 2605)</td>
</tr>
<tr>
<td>North Yorkshire</td>
<td>103</td>
<td>1043 (975, 1110)</td>
<td>885 (705, 1064)</td>
<td>1677 (1111, 2243)</td>
</tr>
<tr>
<td><strong>East Riding</strong></td>
<td>106</td>
<td>1613 (1513, 1713)</td>
<td>1328 (1018, 1639)</td>
<td>1862 (1544, 2180)</td>
</tr>
<tr>
<td><strong>CABG rates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leeds</td>
<td>100</td>
<td>1387 (1285, 1489)</td>
<td>1001 (785, 1217)</td>
<td>1869 (1577, 2161)</td>
</tr>
<tr>
<td>United Health</td>
<td>119</td>
<td>690 (612, 768)</td>
<td>1006 (671, 1340)</td>
<td>659 (399, 920)</td>
</tr>
<tr>
<td>West Yorkshire</td>
<td>121</td>
<td>796 (727, 866)</td>
<td>1023 (748, 1298)</td>
<td>641 (386, 895)</td>
</tr>
<tr>
<td>Bradford</td>
<td>113</td>
<td>834 (725, 933)</td>
<td>567 (345, 792)</td>
<td>1002 (711, 1294)</td>
</tr>
<tr>
<td>Wakefield</td>
<td>121</td>
<td>921 (824, 1018)</td>
<td>721 (366, 1100)</td>
<td>1252 (821, 1684)</td>
</tr>
<tr>
<td>North Yorkshire</td>
<td>103</td>
<td>662 (608, 715)</td>
<td>642 (492, 793)</td>
<td>784 (594, 1175)</td>
</tr>
<tr>
<td>East Riding</td>
<td>106</td>
<td>885 (811, 959)</td>
<td>759 (523, 995)</td>
<td>854 (639, 1069)</td>
</tr>
</tbody>
</table>

CHD = coronary heart disease.
laboratory at Hull Royal Infirmary to undertake angiography under supervision, for a single session (1/2 day) each week at a rate of 2–3 each session, but not necessarily on United Health patients. There were no private providers of tertiary cardiology services in the United Health area, the nearest being at Leeds.

The method, together with a discussion of the use and limitations of Super Profile Lifestyle groupings (table 1) is described in detail elsewhere.15 In summary, 1991 census population for the former Yorkshire Region and its seven constituent districts were electronically assigned to a Lifestyle group, by gender and five year age band, according to ED characteristics. These data provided the population denominator. Using regionally collated hospital activity data,23 patients aged ≥ 25 years with a primary diagnosis of ischaemic heart disease who underwent coronary angiography, CABG or PTCA as a primary procedure were also assigned to a Lifestyle group, using their postcodes. Average annual age standardised utilisation rates per million population were calculated for the region and for each district by Lifestyle group using 1992–4 activity data, standardised to the European Standard Population.24 Utilisation rates were also calculated using 1994–6 activity data for residents of the United Health district. It should be noted that as rates per million quoted are for those aged ≥ 25 years, they are around 30% higher than if a total population rate were calculated. Ischaemic heart disease standardised mortality ratios for Lifestyle groups were used as a proxy for need.25

### Results

United Health investigation rates (1992–1994), before increasing resource input, were the third lowest of the seven health authorities in the Yorkshire Region despite the district’s high SMR (119 in 1993) (fig 1). Revascularisation rates were the second lowest, there being an almost threefold difference across districts (fig 2). Within the district, both investigation and revascularisation rates were inequitable, there being a decreasing trend across Super Profile Lifestyle groups from the A-Z affluent Achievers to the Have-Nots despite a twofold increase in SMRs indicating the greater need of the more deprived (figs 3 and 4). The ratio of the angiography rate for the A-Z affluent Achievers to that for the Have-Nots was 1.2:1 (that is, the angiography rate for the most deprived group was 19% less than that for the most affluent group, a difference of 284 per million procedures, table 3). The corresponding ratio for revascularisation rates was 1.53:1 (that is, 34% less procedures for the Have-Nots than the A-Z affluent Achievers, or 347 per million less, table 3). Had private hospital data been available, and an additional 10–20% procedures included in the analysis, these ratios would have been greater.25

After a concerted effort to increase resources for tertiary cardiology in Grimsby and Scunthorpe district, considerably higher overall procedure rates for 1994/6 were achieved (a 41% increase in investigation and a 47%

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Angiography average annual rate per million (with 95% confidence intervals)</th>
<th>CABG/PTCA average annual rate per million (with 95% confidence intervals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992–4</td>
<td>1272 (1166, 1377)</td>
<td>690 (612, 768)</td>
</tr>
<tr>
<td>1994–6</td>
<td>1796 (1690, 1902)</td>
<td>1012 (935, 1090)</td>
</tr>
<tr>
<td>Change</td>
<td>41% increase</td>
<td>47% increase</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lifestyle Group</th>
<th>Angiography Rate</th>
<th>Have-Nots</th>
<th>Difference</th>
<th>A-Z affluent Achievers</th>
<th>Have-Nots</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992–4</td>
<td>1489 (1082, 1985)</td>
<td>1205 (851, 1558)</td>
<td>−284 (HN 19% &lt; AA)</td>
<td>1006 (671, 1340)</td>
<td>659 (399, 920)</td>
<td>−347 (HN 34% &lt; AA)</td>
</tr>
<tr>
<td>1994–6</td>
<td>1362 (956, 1769)</td>
<td>2188 (1835, 2541)</td>
<td>+826 (HN 61% &gt; AA)</td>
<td>653 (319, 988)</td>
<td>918 (657, 1178)</td>
<td>+265 (HN 41% &gt; AA)</td>
</tr>
</tbody>
</table>
Investment in coronary angiography and revascularisation

Figure 3 Age/sex standardised angiography rates for 1992/4 and 1994/6, SMRs for 1987/91.

Figure 4 Age/sex standardised CABG/PTCA rates for 1992/4 and 1994/6. Regression analysis is used for linear trends.

KEY POINTS
- Districts with high overall intervention rates (angiography and revascularisation) have equitable provision across socioeconomic groups.
- Within districts with low overall rates, deprived Super Profile groups with high SMRs have lower intervention rates.
- Increasing resources for tertiary cardiology in one district so that overall intervention rates attained recommended levels increased equity across socioeconomic groups despite no specific targeting.
- Reducing inequalities in coronary heart disease is an Our Healthier Nation priority. Increasing district rates to recommended levels may help in part to achieve this target.

increase in revascularisation rates), table 3. Early indications reveal the trend for angiographies across socioeconomic groups also became more equitable (fig 3). The ratio of angiography rates in the most affluent group (Affluent Achievers) to that in the most deprived group (Have-Nots) decreased by 48% to 0.62:1. The most deprived now received 61% more investigations than the most affluent—that is, a rate difference of +826 angiographies per million (table 3). To test this perceived improvement statistically, the ratios of angiography rate to SMR for Lifestyle groups I-IX, Country Life to Have-Nots, were subtracted from the ratio for Affluent Achievers in the period 1992/4 and repeated for 1994/6. On the premise that for equity on the basis of need as determined by SMR all ratios should be the same as for the most affluent group, mean differences before and after were compared using Student’s paired t test. The ratio of angiography rate to SMR by deprivation was significantly closer to the most affluent group (Affluent Achievers I) for all other Lifestyle groups (II to X) in 1994/6 than in 1992/4, (t = −5.71, p<0.001, mean difference 1992/4 = −7.46, mean difference 1994/6 = −1.2) confirming improved equity.

The ratio of revascularisation rates in the Affluent Achievers to that in the Have-Nots also decreased, this time by 54% to 0.46:1, with the most deprived now receiving 41% more (265 per million more) procedures than the most affluent (table 3). However, the considerable variation in rates across the Lifestyle groups resulted in little improvement in the linear trend for revascularisations (fig 4). The ratio of revascularisation rate to SMR by deprivation was, however, also closer to the most affluent group in the latter period than in the former (t = −10.12, p<0.001, mean difference 1992/4 = −8.56, mean difference 1994/6 = 0.92), again indicating improved socioeconomic equity.

Discussion
It is now openly accepted that socioeconomic inequalities in health can be reduced by26: (1) improving social and economic circumstances of society’s poorer groups, (2) improving environmental conditions, and (3) encouraging healthier behaviours.

Despite having a government openly committed to reducing inequalities, tackling the first two will be a long and difficult process, and there is little evidence of the effectiveness of health promotion programmes designed to tackle the third.27 Access to high quality services is also recognised as an important determinant of health status.28 It has been suggested that policies designed to equalise access to acute health services, while doing little to tackle the underlying causes of inequalities in health status, might be much more cost effective in tackling the consequences of deprivation.29 It would be expected, therefore, that ensuring better access to angiography and revascularisation for people with coronary heart disease in more deprived areas, would help to reduce inequalities in ill health and in mortality30 in the interim period.

Targeting deprived groups for investigation and treatment for heart disease is more difficult than targeting for health education, as service related factors (clinical judgement, attitudes to patients, appropriateness) as well as patient related factors (attitudes, expectations, illness behaviours) are important. Such a process could be facilitated by “flagging” the health records of patients from deprived areas.

Increasing overall resources in an untargeted manner is much simpler. Previous studies examining impact on socioeconomic inequality
of uptake have looked mainly at prevention interventions. Reading et al\textsuperscript{25} found that despite substantial increases in immunisation uptake, inequalities persisted or widened, whereas Smith et al\textsuperscript{26} found that improvements in vision screening coverage selectively benefited children from poorer areas.

Early indications from this study have shown that increasing overall resource input to tertiary cardiology may narrow inequalities in angiography utilisation rates between the socioeconomically deprived (Have-Nots) and the privileged (Affluent Achievers). This may mean that the needs of the articulate and more demanding affluent were already being met, and additional resources began to meet more of the needs of the less empowered, less advocated deprived. This would suggest there is a minimum (threshold) angiography rate required below which inequity is probable.

Angiography is the gateway to revascularisation,\textsuperscript{27} but there is less clear evidence of a corresponding effect on revascularisation. Statistical significance testing suggests improved equity, but regression analysis (linear trend) shows little improvement. The latter may, however, be skewed by outlier points, for example, Country Life group. It also may be that insufficient time has elapsed since the interventions were introduced in 1994 and 1995, and that when 1996/8 HES data become available greater equity will be clearly shown here as well. Should this not be seen then either the revascularisation rate is still too low to meet overall need, or equity can only be achieved by specifically targeting those in lower socioeconomic groups. This may be difficult to determine without private hospital data to assess any concurrent changes in privately purchased procedures. Other potential explanations are that contradictions to revascularisation, for example, obesity, smoking, comorbidities, possibly more prevalent in lower socioeconomic groups may influence clinical appropriateness for revascularisation, or that angiography revealed more non-cardiac disease in lower socioeconomic groups. This latter hypothesis is unlikely as investigations are more likely to be undertaken to allay the fears of the middle class “worried well”. A detailed case-not study would be required to ascertained this.

Although this research suggests that an untargeted increase in resources for tertiary cardiology services can narrow socioeconomic inequalities in service utilisation, methodological limitations have to be considered. These have been discussed in depth elsewhere.\textsuperscript{28} It is considered that scope for the ecological fallacy to operate is limited. Geographical proximity has also been shown elsewhere in part to explain differences in revascularisation rates.\textsuperscript{29} This may be responsible for the very high rates shown in Leeds, a district with two providers of tertiary cardiology services (at the time of study) despite a relatively small geographical area. However, Grimsby and Scunthorpe district was chosen for the examination of the impact of increased resource because it has no tertiary centre. Hence, differences shown are over and above those resulting from geographical proximity.

Finally, reducing inequalities in coronary heart disease is an “Our Healthier Nation\textsuperscript{30} priority. While it is not possible to prove our interventions are solely responsible for the increased equity shown, increasing district rates to recommended levels may begin to reduce the gap between the privileged and the deprived, particularly if specifically targeted.

We thank John Reed of the Information Department of the former Yorkshire Regional Health Authority for hospital episode data, and Mike Ditchfield, Assistant Director of Commissioning at United Health (now South Humber Health Authority) for information about changes in tertiary cardiology service provision. We also thank Professor Bob Haward, former Director of Public Health for YRHA for permission to use SMRs from the 1994 annual report.

Funding: South Humber Health Authority. Conflicts of interest: none.

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