Socioeconomic inequalities in neonatal intensive care admission rates

J Jenkins,[1] E McCall,[2] E Gardner,[3] K Casson,[3] H Dolk[3]

[1] Queen's University Belfast, Paediatric Department, Antrim Hospital, Antrim, UK; [2] Queen's University Belfast, UK; [3] University of Ulster, Jordanstown, UK

Correspondence to: Dr John Jenkins, Queen's University Belfast, Paediatric Department, Antrim Hospital, Antrim BT41 2RL, Northern Ireland, UK; j.jenkins@qub.ac.uk

Accepted 12 May 2009
Published Online First 19 May 2009

ABSTRACT

Objective: To examine socioeconomic inequalities in neonatal intensive care (NIC) admissions relating to preterm birth, intrauterine growth restriction (IUGR), multiple births and other conditions.

Methods: Retrospective review of all NIC admissions from 1996 to 2001 throughout a geographically defined region. Area deprivation indices were grouped into quintiles from least (1) to most (5) deprived. Admissions were classified by predefined hierarchical criteria.

Results: The rate of admissions was 31.4 per 1000 births. There was a J-shaped relation with socioeconomic group (28.1 NIC admissions per 1000 in quintile 1, 34.0 in quintile 5 and below 28 in the other quintiles). The most deprived areas had a rate 19% above the regional average. The relation with socioeconomic group differed significantly according to primary reason for admission. The rates of admissions with significant prematurity (34% of all admissions) and IUGR as primary reason were highest in quintile 5 (18% and 41% above the regional average, respectively). This contrasted with the rate of admission for multiple birth which was highest in quintile 1 (45% above average). These differences provided the main explanation for the J-shaped overall curve.

Conclusions: Measures to alleviate deprivation and to improve the preterm birth and IUGR rates in deprived groups would have the greatest potential to reduce inequality in need for NIC admission. Efforts to achieve targets for reduction in infant mortality need to take account of the different effects of socioeconomic inequalities for different conditions and groups of infants.

What is already known on this topic

There are socioeconomic inequalities in rates of infant mortality and low birth weight.

What this study adds

- The most deprived group of the population has an NIC admission rate 19% above the regional average.
- Measures to alleviate deprivation and improve the preterm birth and IUGR rate in deprived groups would have the greatest potential to reduce this inequality.
- Efforts to achieve targets for reduction in infant mortality need to take account of the different effects of socioeconomic inequalities for different conditions and groups of infants.

The 2007 report by the Comptroller and Auditor General "Caring for Vulnerable Babies: The Organisation of neonatal Services in England" highlighted the increasing numbers of newborn infants needing specialist care, and the correlation between high neonatal death rates and lower socioeconomic groups.[1] Approximately 1 in 12 liveborn infants are admitted to a neonatal facility, with half of these receiving neonatal intensive care (NIC).[2] Many of these infants have conditions such as congenital malformations, prematurity, intrauterine growth restriction (IUGR) or infection, which are known to be linked to socioeconomic deprivation.[3] However, other risk factors for admission such as multiple birth and elective caesarean section may have a different association and even be linked to higher socioeconomic status through factors such as their links to maternal age, use of assisted reproductive technology and ability to pay for private care.

Previous work has demonstrated that social deprivation correlates with perinatal and neonatal mortality. The report of the Confidential Enquiry into Maternal and Child Health on Perinatal Mortality 2006 has reported rates of stillbirth and neonatal mortality for mothers resident in the most deprived areas (9.3) that were almost double those in the least deprived areas (5.3).[4] A Department of Health review has also reported a widening from 13% (1997–1999) to 17% (2004–2006) in the relative gap between infant mortality rate in the routine and manual group and in the total population.[5]

Smith *et al* reported wide socioeconomic inequalities that persist over time and influence the incidence of very preterm birth.[6] Social deprivation is also a risk factor for low birth weight and thus can be expected to influence the need for neonatal intensive care. Howell and Vert reported in 1993 that socioeconomic status was important in determining use of neonatal intensive care in both France and the United States.[7] A more recent UK study also concluded that social deprivation correlates strongly with neonatal morbidity and the need for neonatal unit admission.[3]

In this paper, we use a population-based database of all NIC admissions throughout Northern Ireland to examine socioeconomic inequalities in admissions by primary reason for admission. This information is useful for appropriate distribution of resources, for understanding the socioeconomic profile of families receiving services and for predicting the effect of trends in risk factors for NIC admission on the development and planning of the service regionally and nationally. It is part of a larger study that has assessed

Table 1 Births and neonatal intensive care admissions 1996–2001 by ward-level socioeconomic quintile

Socioeconomic quintile	Number of births	NIC admissions	Admission rate/1000 births	95% Confidence intervals	
				Lower	Upper
1 (least deprived)	29 954	842	28.1	26.2	30.0
2	24 469	617	25.2	23.2	27.2
3	23 233	638	27.5	25.4	29.6
4	25 020	661	26.4	24.4	28.4
5 (most deprived)	34 182	1161	34.0	32.1	35.9
Missing	1586	424			
Total	138 444	4343	31.4	30.5	32.3
Total where quintile known	136 858	3919	28.6	27.7	29.5

socioeconomic inequalities in adverse pregnancy outcomes in Northern Ireland, which is a region of the UK with high levels of socioeconomic deprivation.[8]

METHODS

Since 1994 all neonatal intensive care units in Northern Ireland have prospectively collected and returned a range of socio-demographic, obstetric and neonatal intervention and outcome data items to a central NICORE database (Neonatal Intensive Care Outcomes Research & Evaluation). One proforma is completed by medical or nursing staff in accordance with agreed definitions for each infant admitted to any neonatal facility within the first four weeks of life. Each episode of care is then linked to create a single record for each infant.

For the purposes of this study a subset of NICORE data items were extracted for infants receiving level 1 and/or level 2 care (categorised by the British Association of Perinatal Medicine levels of care)[9] during the period 1 January 1996 to 31 December 2001. These data variables included year of birth, postcode, birthplace, marital status of mother, age of mother, antenatal risk factors, birth weight, gestation, gender, mode of delivery, small for gestational age, number of fetuses this pregnancy, congenital malformations, diagnoses and final outcome.

Each record was reviewed by one of the authors (JJ) and a primary reason for admission was assigned according to the following hierarchical criteria:

- Congenital malformation (excluding mild conditions such as skin tags, talipes, hypospadias, mild dysmorphic features)
- Significant prematurity: gestational age $\leqslant$32 weeks (no congenital malformation). This cut-off for gestation was chosen pragmatically as infants born at gestational ages between 33 weeks and 37 weeks are unlikely to require intensive care unless there is another complicating condition
- Small for gestational age (IUGR—birth weight less than 10th centile for gestational age) (>32 weeks' gestation, no congenital malformations)
- Multiple birth (>32 weeks' gestation, no congenital malformations, no IUGR)
- Elective caesarean section at 37 or 38 weeks' gestational age (>32 weeks' gestation, no congenital malformations, no IUGR, singleton pregnancy)
- Other (>32 weeks' gestation, no congenital malformations, no IUGR, singleton pregnancy, not elective caesarean section at 37 or 38 weeks' gestation).

A primary reason for admission to the NICU was not assigned when there was insufficient information to make an informed decision (57 cases). Area deprivation indices were allocated by linkage of post-coded data to wards. The socio-economic index was the Northern Ireland Multiple Deprivation Measure 2001 (Noble index), using only its income domain for the 1991 census wards. The Registrar General birth data were used to provide the denominator for the number of live births in the population, similarly linked by postcode to wards to obtain deprivation quintiles. Indices were grouped into quintiles—that is, 20% of wards were in each quintile, from least deprived (1) to most deprived (5).

χ^2 Tests were used to test for heterogeneity or trend of NIC admission rates across quintiles, and to test for an association between primary reason for admission and deprivation quintile.[10] No attempt was made to correct for risk factors such as maternal age, since our aim was to describe the overall gradient, not to provide a causal model.

RESULTS

There were 4343 infants admitted to neonatal intensive care among 138 444 live births in 1996–2001, a rate of 31.4 per 1000 births (table 1). Of these 92% were discharged alive. The rate of admissions increased during the study period (from 27 per 1000 in 1996 to 33 in 2001).

The socioeconomic quintile of residence could be determined for 90.2% (3919/4343) of NIC admissions and 98.9% of births. For those with known socioeconomic status, the NIC admission rate was 34.0 per 1000 in the most deprived quintile, 28.1 in the least deprived, and below 28 in the other quintiles (fig 1), a J-shaped relation. These differences were statistically significant (χ^2 for trend $=21.2$, $p<0.0001$).

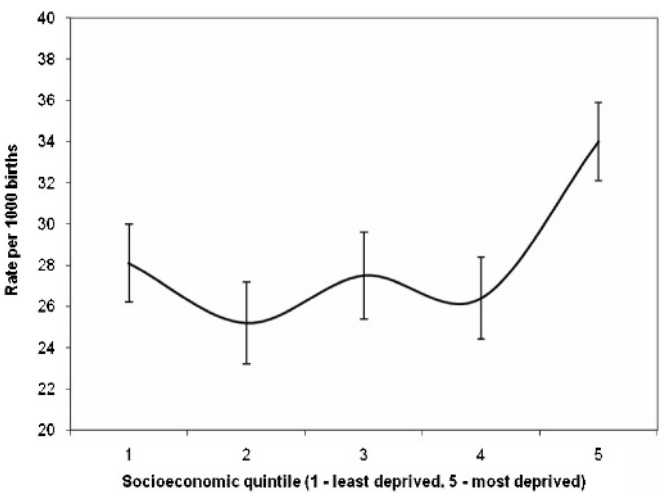

Figure 1 Neonatal intensive care admission rates and 95% confidence intervals 1996–2001 by socioeconomic quintile.

Arch Dis Child Fetal Neonatal Ed 2009;**94**:F423–F428. doi:10.1136/adc.2008.146464

Table 2 Neonatal intensive care admissions 1996–2001 by primary reason for admission (as defined by hierarchical criteria)

Reason for admission	Number	% Admissions	Rate/1000	95% Confidence intervals	
				Lower	Upper
Congenital malformation	481	11.1	3.2	2.9	3.4
Significant prematurity	1455	33.5	9.7	9.2	10.3
Small for gestational age	364	8.4	2.4	2.1	2.7
Multiple birth	217	5.0	1.4	1.2	1.6
Elective caesarean section	178	4.1	1.2	1.0	1.4
Other	1591	36.6	10.4	9.9	10.9
Missing	57	1.3			
Total	4343	100.0			

The assigned primary reason for admission, as categorised above, was congenital malformations in 11%, significant prematurity 34%, small for gestational age 8%, multiple birth 5% and elective caesarean section at 37 or 38 weeks 4% (table 2). The proportion discharged alive was lowest for congenital malformation (81.5%) and significant prematurity (86.7%) with over 97.5% discharged alive in all other categories. The primary reason for admission was classified as other where this information was available but did not fall into any of the defined categories. This included infants with conditions such as respiratory illnesses, patent ductus arteriosus, infection, necrotising enterocolitis, seizures, etc, as the number of infants with each of these conditions was insufficient for meaningful separate analysis.

Table 3 shows the numbers and rates of admissions by primary reason in each socioeconomic quintile. There was a significant association between primary reason and quintile (fig 2; χ^2 for heterogeneity $= 70.4$, $p<0.0001$). Admissions associated with congenital malformation (overall admission rate 3.2 per 1000) showed differences across quintiles, but not a consistent gradient, though the lowest rate of malformation associated admissions was in the least deprived quintile. Significant prematurity (overall rate 9.7) showed a gradient of increasing frequency with increasing deprivation, from 8.6 in the least deprived quintile to 11.5 in the most deprived. Small for gestational age (overall rate 2.4) showed a J-shaped association with socioeconomic deprivation, with the highest rate of 3.4 in the most deprived quintile. Multiple births (overall rate 1.4) showed an inverse association with socioeconomic deprivation, with higher rates of 2.1 and 1.8 in the least deprived quintiles. Elective caesarean section showed a shallow U-shaped relation, with slightly higher rates in the least and most deprived quintiles. The differences in admission rate by quintile were statistically significant for each primary reason ($p<0.01$) except for caesarean section ($p = 0.76$). Separate analysis of the periods 1996 to 1998 and 1999 to 2001 demonstrated no significant difference in the shape of the overall curve.

DISCUSSION

We found a trend of increase in the overall rate of NIC admissions. Numbers are too small for precise analysis, but contributory factors could be an increasing incidence of low birth weight, a rise in multiple births and rise in maternal age. Initial analysis of our larger study has shown a trend of increase in the overall percentage of live births that were multiple (from 2.76 in 1996 to 3.18 in 2001), <2500 g (5.64 in 1996 to 5.97 in 2001) and <32 weeks' gestation (1.01 in 1996 to 1.14 in 2001). It has also found that in Northern Ireland, small for gestational age is highly associated with socioeconomic deprivation and prematurity less so.[8] Our previous work has demonstrated an increase from 19% in 1994–6 to 26% in 1999–2000 in the percentage of infants admitted to the NIC with birth weight $\leqslant 1.5$ kg, and from 7% to 11% for those $\leqslant 1.0$ kg.[2]

The highest rates of NIC admissions related to the most deprived areas of residence, which had 19% more admissions than the average for Northern Ireland. This was particularly marked where the primary reason for admission was small for gestational age (41% more than average), significant prematurity (18%) or "other" (21%). Together these explain 42% of neonatal intensive care admissions, and it is clear therefore that

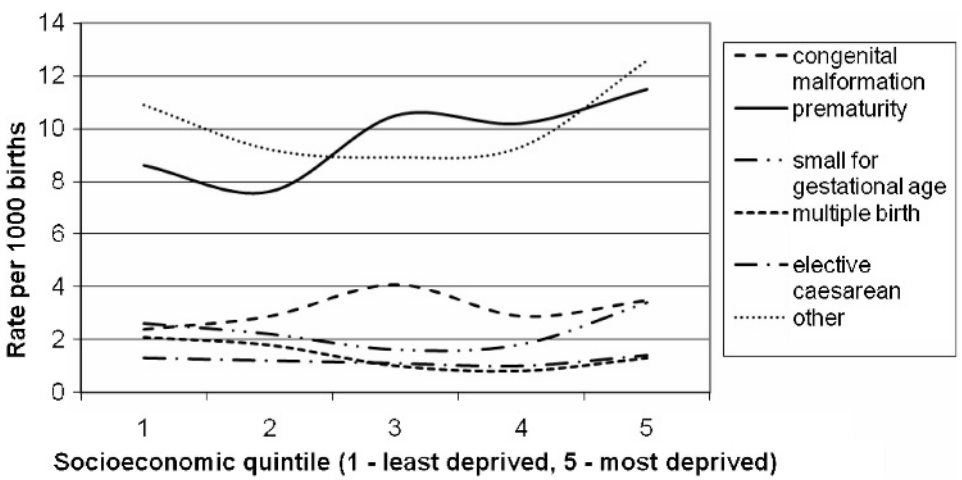

Figure 2 Neonatal intensive care admission rates 1996–2001 by socioeconomic quintile and primary reason.

Table 3 Neonatal intensive care admissions 1996–2001 by socioeconomic quintile and primary reason for admission (as defined by hierarchical criteria)

	Congenital malformation		Significant prematurity		Small for gestational age		Multiple birth		Elective caesarean section		Other	
Socioeconomic quintile	No	Rate	No	Rate	No	Rate	No	Rate	No	Rate	No	Rate
1 (least deprived)	73	2.4	256	8.6	78	2.6	62	2.1	38	1.3	326	10.9
2	72	2.9	186	7.6	54	2.2	45	1.8	29	1.2	226	9.2
3	94	4.1	243	10.5	36	1.6	24	1.0	25	1.1	206	8.9
4	73	2.9	254	10.2	45	1.8	20	0.8	25	1.0	233	9.3
5 (most deprived)	119	3.5	392	11.5	116	3.4	44	1.3	46	1.4	431	12.6
Total	431	3.2	1331	9.7	329	2.4	195	1.4	163	1.2	1422	10.4

attempts to reduce socioeconomic deprivation have the potential to reduce NIC rates and their associated costs to the infant, family and health service.

Multiple births explain 5% of NIC admissions when not associated with significant prematurity or IUGR, or 17% when all multiple births are considered. The least deprived quintile had a 45% greater admission rate for multiple birth as a primary reason than the Northern Ireland average. Multiple births have been rising in frequency in Northern Ireland related to increasing maternal age and use of assisted reproductive technology, and both these factors are associated with higher socioeconomic status. Multiple birth, whether as a primary reason for admission or as the underlying reason for preterm birth and IUGR, was the main explanation for the small but consistent tendency for babies from the least deprived areas to have higher NIC admission rates than those from the middle quintiles. Maternal age over 40, also shown in the larger study to be more common in less deprived areas and associated with higher preterm births and IUGR rates, would also have contributed to slightly elevated NIC admission rates in the least deprived areas. Paradoxically, the increase in multiple births has led to a slight narrowing of overall socioeconomic inequality in NIC admission. Measures to reduce the rate of multiple births, while of overall benefit, would initially increase inequalities, unless accompanied by measures to reduce the multiple birth rate.

Elective caesarean section carries with it a risk of complications leading to NIC admission, and was found to account for 4% of admissions in this population. It did not show a strong relation with socioeconomic status in our data, although it is known to be more prevalent among more affluent mothers.

The results of this study confirm previous findings that social deprivation correlates with the need for admission to neonatal intensive care, with different relative impacts depending on the diagnosis and reason for admission. Manning *et al* reported a strong correlation between social deprivation and admission for all indications except jaundice and feeding problems in all admissions for special and intensive care in a single centre. They suggested that this association reflected a pervasive effect of socially determined factors on placental function and fetal nutrition, in addition to a range of respiratory conditions.[3] However, special care admission, not included in our study, is also influenced by other factors than need, including cot availability. In contrast, neonatal intensive care is accessed on the basis of need only, and over this time period no babies needing NIC admission were unable to access it.

The study was limited by the need to retrospectively assign a primary reason for admission to each episode based on the list of diagnoses recorded at discharge. However this was undertaken by a single individual so any bias is likely to affect the whole dataset to a similar extent. A strength of the study is that the dataset included all live births and NIC admissions in the entire population of the region with very little transfer out of mothers or infants.

The UK government has recognised that although death rates in the first year of life have fallen in recent decades this trend has diminished in recent years, and the UK compares unfavourably with other countries in similar economic situations. The importance of this issue has led to development of an NHS target "by 2010 to reduce inequalities in health outcomes by 10% as measured by infant mortality and life expectancy at birth". However, a review revealed that the infant mortality rate among the routine and manual group remained 17% higher than in the total population in 2004–6, compared with 18% higher than in the total population in 2003–5 and 19% higher than in the total population in 2002–4. This compares with 13% higher in the baseline period of 1997–9.[4] The Department of Health is quoted in the report of the House of Commons Committee of Public Accounts as "redoubling its efforts including issuing a practical guide for Primary Care Trusts and health communities, and reviewing its health inequalities strategy".[11]

The review of the Health Inequalities Infant Mortality Public Service Agreement (PSA) Target concluded that "the evidence about the effectiveness of interventions to reduce infant mortality is weak", and recommended improvement of data quality and strengthening of the evidence base.[12] To make progress towards achieving published UK targets attention should be given to the potential for alleviation of deprivation and targeted improvement of pregnancy outcomes among the more deprived groups to reduce NIC admissions with their considerable impact on babies, families and health service costs. Efforts to achieve targets for reduction in infant mortality also need to take account of the different effects of socioeconomic inequalities for different conditions and groups of infants. Routine analysis and reporting of NIC admissions for defined populations is an important part of monitoring progress towards this objective.

Acknowledgements: The authors are indebted to Elaine Hand and Sally Cook for their contributions to this work.

Funding: This project was funded by the Research and Development Office of the Northern Ireland Health and Personal Social Services.

Competing interests: None.

Provenance and peer review: Not commissioned; externally peer reviewed.

REFERENCES

1. **Comptroller and Auditor General**. *Caring for vulnerable babies*. London: The Organisation of Neonatal Services in England, 2007. www.official-documents.gov.uk/document/hc0708/hc01/0101/0101.asp (accessed 17 March 2009).
2. **Jenkins J,** Alderdice F, McCall E. Improvement in neonatal intensive care in Northern Ireland through sharing of audit data. *Quality and Safety in Health Care* 2005;**14**:202–6.
3. **Manning D,** Brewster B, Bundred P. Social deprivation and admission for neonatal care. *Arch Dis Child Fetal Neonatal Ed* 2005;**90**:337–8.

4. **Confidential Enquiry into Maternal and Child Health**. *Perinatal mortality 2006: England, Wales & Northern Ireland*. London: CEMACH, 2008.
5. **Department of Health**. *Tackling health inequalities: 2007. Status report on the Programme for Action*. London: DH, 2007 www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4117696 (accessed 17 March 2009).
6. **Smith LK,** Draper ES, Manktelow BN, *et al*. Socioeconomic inequalities in very preterm birth rates. *Arch Dis Child Fetal Neonatal Ed* 2007;**92**:11–4.
7. **Howell EM,** Vert P. Neonatal intensive care and birth weight-specific perinatal mortality in Michigan and Lorraine. *Pediatrics* 1993;**91**:464–9.
8. **Dolk H**, ed. *Targeting social need: monitoring socioeconomic inequalities in pregnancy outcome*. Final report to the Northern Ireland Research and Development Office, 2008.
9. **British Association of Perinatal Medicine and Neonatal Nurses Association**. Report of the Working Group of the British Association of Perinatal Medicine and Neonatal Nurses Association on categories of babies requiring neonatal care. *Arch Dis Child* 1992;**67**:868–9..
10. **Bland M.** *An introduction to medical statistics*. 3rd ed. Oxford: Oxford University Press, 2000.
11. **House of Commons Committee of Public Accounts**. *Caring for vulnerable babies: the reorganisation of neonatal services in England*. London: 2008. www.publications.parliament.uk/pa/cm200708/cmselect/cmpubacc/390/390.pdf (accessed 17 March 2009).
12. **Department of Health**. *Review of the health inequalities infant mortality PSA target*. London: DH, 2009. www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_065544 (accessed 17 March 2009).