Hospital Practice

IS OBSTETRICS SAFE IN SMALL HOSPITALS?

Evidence from New Zealand's Regionalised Perinatal System

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Summary Perinatal mortality rates were determined for all public maternity hospitals in New Zealand for the years 1978–1981. Level 1 maternity hospitals—mostly small rural units staffed by general practitioners and midwives—had lower birth-weight-specific perinatal mortality rates in all but the lowest birth-weight categories than the better equipped hospitals to which they refer. This probably reflects the cautious antenatal practices of general practitioners, and the effective regionalisation of perinatal services in New Zealand. It is also possible that there is an advantage, particularly for normal birth-weight children, in being born in smaller obstetric units. There is no evidence that a satisfactory outcome depends on a minimum number of deliveries.

INTRODUCTION

WHERE should babies be born, and who should deliver them? Obstetric practice has changed considerably in the last decade, pulled by two powerful but at times opposing forces. Major advances in the ability to detect and intervene in cases of high-risk pregnancy have increased the complexity and the technology of obstetric care. Meanwhile, public and professional demands for less intervention in normal pregnancy have made it more difficult to reconcile optimum medical outcome with less intrusive obstetric practice. While it is clear that sick neonates and women with complicated pregnancies are best cared for in large and well-equipped medical centres, the degree of training or experience needed to practise normal obstetrics is unknown.

Regionalisation has been recommended as the most effective strategy for improving quality of care in volume-sensitive conditions,[1,2] and has been widely used to provide obstetric and perinatal services.[3–7] Regionalisation is not an unmixed blessing, however, because it tends to increase the size and complexity of referral hospitals and may diminish access to care for some people, particularly those in remote or rural areas.[8,9] In many countries, including New Zealand, small maternity hospitals are being closed, partly because of fears that the quality of care may be inferior in small hospitals (the economic efficiency of smaller units is another factor). Nevertheless, the relation between volume and outcome of care in a regionalised perinatal system has not been investigated adequately. Is there a volume threshold below which obstetric care becomes unduly hazardous for patients?

Background

Obstetric care in New Zealand is largely financed by central government. In 1983 there were over 100 public maternity units throughout the country, administered by 29 publicly elected hospital boards. Virtually all deliveries occur in such units, with general practitioners and specialist obstetricians delivering about the same number of babies. All women have access to free maternity care. Regionalisation of obstetric services began in the 1970s, and by 1980 most maternity units were part of a formal regionalised perinatal care system.[10–12] Partly as a result of regionalisation, 33 rural maternity units were closed between 1970 and 1984; most of these units were the only hospitals in the rural communities that they served. Our study was designed to assess whether the low volume of deliveries in the many remaining small hospitals affects perinatal mortality, in the context of a regionalised system of care.

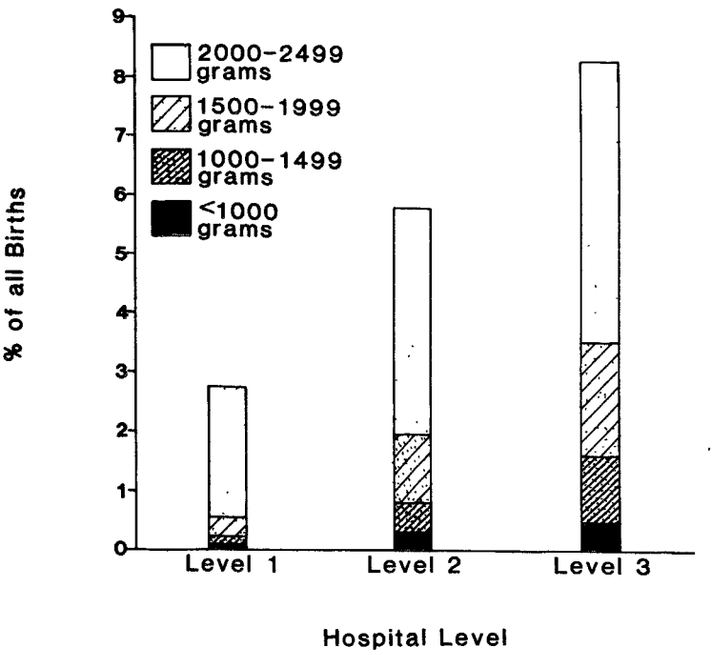

Fig 1—Distribution of low-weight births by hospital level.

METHODS

Data were obtained from the National Health Statistics Centre of New Zealand, which maintains a computerised register of all births and perinatal deaths, including location of each birth and death, place of residence of the parents, and the birth-weight of all liveborn infants. In addition, government publications give detailed annual information on all maternity units within New Zealand, and on the socio-demographic characteristics of the counties in which they are located.[13–16] These data were collected and merged for the years 1978–1981, inclusive.

Following Department of Health guidelines, maternity units functioning during the period of this study were assigned to three mutually exclusive levels of care. Five hospitals were classed as level 3, or tertiary care units for both obstetric and perinatal care. Nineteen hospitals were designated as level 2, reflecting their sub-regional referral role for complicated obstetric and neonatal care not requiring the more specialised equipment and personnel available in the five regional centres. Eighty-nine maternity units were designated as level 1; in general these are much smaller units, usually in rural settings, where virtually all deliveries are carried out by general practitioners working with midwives.

Maternal residence, hospital of birth, and hospital of death were determined for each perinatal death, defined as stillbirths (>28 weeks' gestation) or early neonatal deaths (<7 days of age). The country was then divided into non-overlapping maternity catchment areas, with the centre of each catchment area being the closest maternity hospital. The extent of regionalisation was assessed by determining what proportion of mothers served by level 1 facilities delivered their children in level 2 or level 3 hospitals, and by focusing in detail on the 1% of all pregnancies that ended in a perinatal death. The crude perinatal mortality rate for each hospital was calculated, together with birth-weight-specific perinatal

mortality rates (in 500 g birth-weight increments) according to designated hospital level and volume of deliveries.

RESULTS

Extent of Regionalisation

During the period 1978–1981, there were 206 054 total births, 1388 late fetal deaths, and 1084 early neonatal deaths, yielding a perinatal mortality rate of 12·0/1000 total births. Perinatal mortality rate diminished from 13·0 in 1978 to 10·5 in 1981, continuing a trend that began in the 1930s.

About 40% of all births were to mothers who were served by a level 1 maternity hospital, but only 28·5% of all public hospital births occurred in level 1 hospitals, reflecting the extent of antenatal referral to level 2 and 3 centres. A major cause of referral was prematurity and low birth-weight, as shown by the distribution (fig 1) of the 5·6% of all infants who weighed less than 2500 g at birth (a group which accounts for 60% of all perinatal deaths). Only 2·8% of infants born in level 1 hospitals weighed less than 2500 g; this percentage increases to 8·2% for level 3 hospitals (fig 1). The disparity is even more pronounced for very low birth-weight infants (<1500 g) which account for a third of all perinatal deaths. Only 0·2% of level 1 babies weighed less than 1500 g, in contrast to 1·6% in level 3 hospitals; level 2 hospitals occupied an intermediate position. Since low birth-weight babies are at greater risk than their normal birth-weight counterparts, antenatal screening and regional referral is effective in concentrating the highest risk births in the hospitals designed to deal with them.

Impact of Regionalisation on Hospital-specific Perinatal Mortality Rates

Fig 2 illustrates the relation between volume of deliveries in specific hospitals and crude perinatal mortality rate; a perinatal death is attributed to the hospital in which the baby was born, even if the infant died in a referral hospital after postnatal transfer. Perinatal mortality rates increase with hospital volume, and there is a fairly rigid separation of level 1, 2, and 3 facilities into contiguous clusters, although the differences in rates between level 2 and 3 hospitals are minimal. This is strong evidence that in a regionalised system the highest risk deliveries flow towards the larger, central hospitals. Of the 87 distinct level 1 maternity units, 21 had no perinatal deaths during the four-year study period.

Although low crude perinatal mortality rates in level 1 hospitals are consistent with good obstetric outcome in small hospitals, they do not in themselves constitute proof of high quality care. If the relatively few deaths that do occur in level 1 hospitals are preventable, a significant number of deaths might have been averted by earlier detection and appropriate transfer. In order to investigate this possibility, we computed birth-weight-specific perinatal mortality rates for level 1, 2, and 3 hospitals (table I). Level 1 hospitals have lower birth-weight-specific perinatal mortality rates than level 2 or 3 hospitals in all but the lowest birth-weight categories. The differences are highly statistically significant for normal birth-weight infants but are less pronounced for low and very low birth-weight infants, although level 3 hospitals have significantly lower perinatal mortality rates than level 2 hospitals for infants who weigh less than 1500 g.

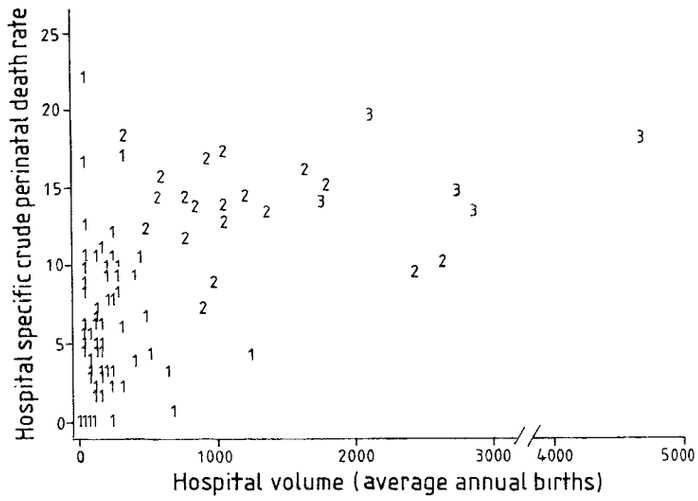

Fig 2—Hospital-specific crude perinatal mortality rates by hospital volume (average annual births) and level.

1 = level 1 (primary level, incomplicated deliveries). 2 = level 2 (secondary level, regional hospitals). 3 = level 3 (tertiary level, major referral centres).

Death rate is expressed per 1000 total births.

Table II shows the relation between birth-weight-specific perinatal mortality rate and hospital volume, measured as the average number of births/year. Smaller hospitals tend to have the lowest perinatal mortality rates, with a highly significant linear trend apparent for infants weighing more than 2500 g. The differences for low birth-weight infants show that the highest rates tend to occur in the middle-sized, predominantly level 2 maternity hospitals. There is no evidence for a minimum number of deliveries below which outcome suffers, although there were insufficient numbers of births in the very small maternity hospitals (<50 deliveries/year) for statistical comparisons. These figures show that in New Zealand, women who deliver in small, mostly rural level 1 hospitals have the highest likelihood of bearing children who will survive the first week of life.

DISCUSSION

Regionalisation of obstetric and perinatal care in several countries has led to great improvements in perinatal outcome.[17–19] Nevertheless, regionalisation requires significant changes in prevailing patterns of medical care, reduces flexibility for patients, doctors, and hospitals, and

TABLE I—PERINATAL MORTALITY RATES BY BIRTH-WEIGHT AND HOSPITAL LEVEL, 1978–81

Hospital level	Birth-weight ⩽1500 g: Perinatal deaths	⩽1500 g: Total births	⩽1500 g: Rate	1500–2499 g: Perinatal deaths	1500–2499 g: Total births	1500–2499 g: Rate	⩾2500 g: Perinatal deaths	⩾2500 g: Total births	⩾2500 g: Rate
Level 1 (n=87)	63	115	547·8	68	1451	46·9	174	54 677	3·2
Level 2 (n=19)	371	638	581·5	308	4291	71·8	421	79 618	5·3
Level 3 (n=5)	367	898	408·7	234	3763	62·2	313	52 191	6·0
Total	801	1651	485·2	610	9505	64·2	908	186 486	4·9

*χ^2; $p<0·01$.

TABLE II—PERINATAL MORTALITY RATES BY BIRTH-WEIGHT AND HOSPITAL VOLUME, 1978–81

Hospital volume (average annual births)	Birth-weight ⩽1500 g			1500–2499 g			⩾2500 g		
	Perinatal deaths	Total births	Rate	Perinatal deaths	Total births	Rate	Perinatal deaths	Total births	Rate
⩽100 (n=39)	6	14	428·6	3	213	14·1	20	7842	2·6
101–200 (n=26)	15	32	468·8	15	393	38·2	43	14 142	3·0
201–500 (n=20)	52	83	626·5	61	764	79·8	96	23 710	4·0
501–1000 (n=11)	105	210	500·0	99	1426	69·3	134	30 210	4·4
1001–2000 (n=9)	252	431	584·7	168	2425	69·3	240	45 652	5·3
>2000 (n=6)	371	881	421·1	264	4284	61·6	375	64 930	5·8
Total	801	1651	485·2	610	9505	64·2	908	186 486	4·9

may engender considerable individual and community resistance. In particular, it may deliberately or inadvertently cause the centralisation of services in a few large urban maternity units, and lead to closure of smaller, more accessible maternity services which serve peripheral communities. Indeed, closure of small units is often proposed as a means of improving the quality of care, and averting unnecessary perinatal deaths.

In New Zealand, most maternity units are small, basic facilities, staffed entirely by general practitioner obstetricians and midwives, and serving a primarily rural population. In this setting, our study shows that most high-risk mothers and babies are detected and referred to better-equipped hospitals before delivery. Relatively few low birth-weight babies are born in small hospitals, and those that are have at least as high a chance of survival as have infants of similar weight born in larger units. Crude perinatal mortality rates increase with hospital volume, with the lowest perinatal mortality rates occurring in the smallest hospitals. We were unable to detect a volume threshold below which obstetric care becomes unsafe.

It is unlikely that level 1 hospitals serve lower risk populations. Perinatal mortality rates are higher for certain segments of the New Zealand population, such as smokers, but these groups live in both rural and urban areas. Crude and birth-weight adjusted perinatal mortality rates vary from one part of the country to another, but the disparities are not great and bear little relation to geographic or socioeconomic differences. These findings differ from previous results. Studies in the United States, in particular, have shown that outcome in terms of birth-weight-specific perinatal mortality rates is worse in small obstetric units than in their better-equipped urban counterparts.[20,21] However, New Zealand differs from the United States in that the system of care is both more tightly organised and more uniform. General practitioners and midwives are responsible for most normal deliveries, and most maternity hospitals have no specialist coverage. Regionalisation has been implemented on a national basis, and antenatal screening—with defined criteria for both consultation and referral—is the norm. The result is a tightly integrated, pyramidal system, in which most high-risk patients are identified by general practitioners and sent to more major referral centres before delivery. In this context, obstetrics *is* safe in small hospitals.

Our findings have major implications for New Zealand and other industrialised countries. In New Zealand, it has been suggested that about half of the smaller obstetric units should be closed, partly on the assumption that hospitals with fewer than 100 deliveries annually are unsafe. Our results do not support that assumption. Even if all preventable perinatal deaths in level 1 hospitals could be averted by closing these units—which is unlikely, since many of these babies would still die even if delivered in better-equipped centres—the impact on the perinatal mortality rate would be negligible.

There is no consensus about the appropriate role for general practitioners in obstetric practice.[22–25] In New Zealand, about half of all deliveries are carried out by specialist obstetricians, working almost entirely in level 2 and 3 units, and half are done by general practitioners, split equally between level 1 and higher level maternity hospitals. Consultation and referral are frequent, and in general working relations among general practitioners and obstetricians within the catchment areas of the various hospital boards are excellent. Our data support the conclusion that this arrangement is functional, and that obstetric care can be effectively partitioned between generalists and specialists. In an ideal regionalised system, mothers whose pregnancies are uncomplicated would be cared for by general practitioners in comfortable, low-technology environments, while women at risk would be transferred to the care of specialists. Our evidence suggests that such an arrangement can be achieved.

Why are perinatal mortality rates so low in the small hospitals in this study—ie, substantially lower than the rates achieved in higher level facilities? The most likely explanation is that the screening protocols used by the general practitioners are so sensitive that most high-risk pregnancies are detected early with prenatal transfer to level 2 and 3 facilities. The fact that the smallest and most remote maternity hospitals have the lowest perinatal mortality rates probably reflects extreme caution on the part of the general practitioners who work there. It is also probable that these doctors refer a relatively large number of patients who do not subsequently require the services of a better-equipped centre; high sensitivity is achieved at the cost of a loss in specificity. Moreover, the quality of care may be better in some respects in small hospitals. The significantly lower perinatal mortality rates of normal-weight infants in level 1 hospitals by comparison with level 2 and 3 facilities may indicate that low-risk mothers fare better in low technology environments. It is possible that small hospitals in New Zealand achieve a better outcome partly because the level of medical intervention and the setting in which birth occurs are more appropriate to the medical and non-medical requirements of the mothers who go there.

This study was supported by a senior international fellowship from the Fogarty International Center, National Institutes of Health, Bethesda, Maryland, USA; and by a grant from the Health Services Research Committee of the Medical Research Council of New Zealand. Dr Reinken and Dr Shoemack are indebted to Dr R. Barker, Director-General of Health, New Zealand for his permission to publish.

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Public Health

DOES FLUORIDATION OF DRINKING-WATER PREVENT BONE FRAGILITY AND OSTEOPOROSIS?

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Summary The incidence of femoral-neck fracture was compared in 2 Finnish towns of similar economic structure, Kuopio and Jyväskylä. Kuopio has fluoridated its drinking-water since 1959, whereas Jyväskylä has only trace amounts of fluoride in its drinking-water. The incidence of bone fragility (measured as femoral-neck fractures) was found to be significantly less in Kuopio than in Jyväskylä. This finding seems to be associated with a fluoride content of 1 mg/l in the drinking-water of Kuopio.

INTRODUCTION

BONE fragility in elderly people is a serious public-health problem, and the pressure on health services will increase as the proportion of elderly people rises.[1-4]

The effect of fluorides on bone tissue has been shown in several studies,[5-14] and the use of fluorides for the treatment of osteoporosis and osteoporotic hip fractures has been recommended.[11,15-25] The fluoridation of drinking-water since 1945 has been successful in the prevention of dental caries in the general population[26-27] and may possibly prevent bone fragility and osteoporosis.

The aim of this study was to examine the possible association between incidence of femoral-neck fractures in the population aged 50 and over and fluoride content of 1 mg/l in drinking-water.

PATIENTS AND METHODS

2 towns of similar economic structure (table I[28]), Kuopio and Jyväskylä, in central Finland, were chosen for this study. The number of inhabitants aged 50 and over (11 244–17 591 in Kuopio and 10 292–14 701 in Jyväskylä) and age and sex distribution during the study period were similar in the 2 towns. Both towns have fluoride in trace quantities in their natural water supplies (0–0·1 mg/l), but Kuopio has fluoridated its drinking-water since 1959 to the level of 1 mg/l. The hardness of the drinking-water, measured as calcium magnesium ion content, is 0·45 mmol/l in Kuopio and 0·46 mmol/l in Jyväskylä.[29] Differences in calcium intake in Finland have been found to be not statistically significant.[30]

We collected all cases of femoral-neck fracture recorded in the hospital discharge data of Finland[4,31] for residents of Kuopio and Jyväskylä, irrespective of where they were treated, for the years 1967–78.

All cases recorded under codes 820·00 and 820·10 in the *International Classification of Diseases* were included; those recorded under 820·90 (sequelae of hip fractures) were not. Only those records in which the diagnosis of hip fracture was the main diagnosis were registered. With the use of the personal code number each patient was registered only once. The patient's age at first hospital admission was recorded as the patient's age in our calculations.

Some readmitted patients from the period immediately before 1967 were included in the study material of the first few years, but

TABLE I—POPULATION IN KUOPIO AND JYVÄSKYLÄ BY INDUSTRY AND SEX

—	Forestry and agriculture %	Industry %	Building construction %	Trade %	Traffic %	Financing %	Public services %	Independent,* non-professional %	Unknown %	NA %
Kuopio:†										
Males (33 345)	4·4	19·1	14·3	11·6	8·5	2·8	17·0	17·2	1·1	4·0
Females (38 466)	3·2	17·0	6·5	13·8	5·0	3·9	23·7	23·3	0·6	3·0
Total number (71 811)	3·8	18·0	10·1	12·8	6·6	3·4	20·6	20·5	0·8	3·4
Jyväskylä:†										
Males (28 658)	1·0	28·2	10·8	11·3	7·7	3·2	16·2	16·8	0·8	4·0
Females (32 929)	0·6	20·6	4·9	14·5	4·6	4·2	24·6	22·4	0·5	3·1
Total number (61 587)	0·8	24·2	7·6	13·0	6·1	3·7	20·7	19·8	0·7	3·4

NA = data not available. *Includes pensioners and inmates of institutions with their family members, and students with their family members who don't belong to parents' household. †Total population.

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