

Paediatric use of intensive care

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Abstract

Objectives – To determine the number of children from a defined population who use intensive care facilities, to analyse bed occupancy data for those children, and to estimate the number of intensive care beds required to satisfy this demand throughout the year.

Design – Examination of admission data books from intensive care units within the four Birmingham health authorities and the neighbouring health authorities.

Results – Two hundred and ninety seven children resident within the four Birmingham health authorities used intensive care facilities in a calendar year. One hundred and forty one (47%) of these were admitted for specialist paediatric services. Of the remaining 156, 106 (68%) were cared for in adult intensive care units, 46 (29%) in a paediatric intensive care unit and four (3%) in a special care baby unit. Use of intensive care varied from none to 11 patients each day, and was lowest in the summer and highest during the winter months. During periods of peak demand, one in 19 000 (5.3/100 000) children were using intensive care facilities.

Conclusions – These data provide a population based minimum need for paediatric intensive care beds. They are higher than previous estimates and do not include provision for children from outside Birmingham, or for those denied intensive care due to bed shortages. These factors and the marked seasonal variation in demand need to be considered when planning intensive care services for children if bed shortages are to be avoided.

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The ability successfully to support children through serious illness and the application of invasive monitoring procedures and organ support has led to increased interest in paediatric intensive care. There are no United Kingdom population based data on paediatric intensive care use. A figure of one bed for 40 000 children has been proposed in the USA,¹ but this may not be applicable to current United Kingdom practice given the differences in definitions of intensive care between this country and the USA and changes in treatment options that have occurred since it was published in 1979.

The number of children admitted to paediatric medical wards varies throughout the year, largely due to an increase in respiratory

infections in winter and spring. It is not known if this variation is also seen in intensive care admissions. The specialist nature of services in intensive care units means that beds cannot be 'borrowed' from other ward areas to meet variations in demand.

The health needs of the major part of Birmingham (the United Kingdom's second largest city) are provided by four district health authorities with a total population of about one million people, including 213 000 children under 15 years of age. Hospitals within these health authorities provide a full range of general and specialist services for children, with the exception of heart transplantation and renal transplantation for those under 2 years of age. As there were no such cases during the study period, we were able to study a population who received all their intensive care services in local units. The provider units include a large children's hospital with an eight bedded paediatric intensive care unit which serves the needs of the hospital's own specialties, but is not funded as a regional unit for general paediatrics.

We undertook a retrospective analysis of admissions to intensive care facilities in Birmingham and surrounding districts during 1991 to determine what use children from a defined population made of intensive care.

Methods

Cases were ascertained by discussion with consultants who held responsibility for intensive care units and a consultant paediatrician in hospitals within the four Birmingham health authorities and each of the neighbouring health authorities. Areas of the hospital which may have provided intensive care to children were identified and data collected from admission books or computerised databases for the period 1 January to 31 December 1991.

Children were included in the study if they were aged less than 15 years on admission to hospital. Children on neonatal intensive care units who had not been discharged from hospital since birth were excluded. Intensive care was defined as admission to an adult or paediatric intensive care unit, or care in another area of the hospital which involved use of a 'unique intensive care unit treatment'. This was defined as one or more of the following: (a) mechanical ventilatory support or endotracheal intubation (except in the short term after, for instance, an operation or cardiorespiratory arrest); (b) continuous invasive measurement of arterial, central venous, or intracranial pressure; or (c) vasoactive drug infusion (that is, dopamine or dobutamine).

The following data were collected: name, postcode, date of birth, hospital number, name

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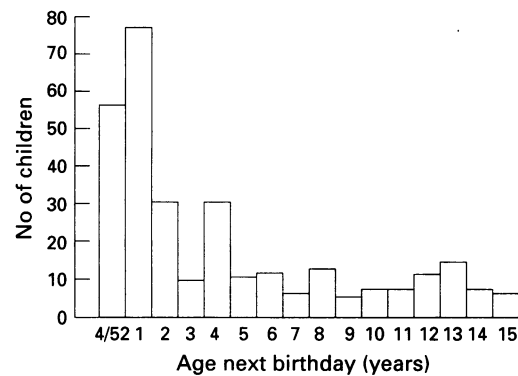


Figure 1 Age of all Birmingham children receiving intensive care in 1991.

of unit admitted to, date of admission and discharge, admission diagnosis, and outcome (died or discharged from the unit alive). Multiple admissions to intensive care of the same child during the year were counted as separate events. If the data were incomplete or the admission book unclear, the patient's hospital notes or the hospital's patient activity system were examined.

The health authority of residence was obtained from the postcode and cross checked using a computerised matching program (West Midlands Regional Health Authority information department).

Specialist paediatric care was defined as cardiology/cardiothoracic surgery, hepatology, oncology, nephrology, or neonatal surgery undertaken at Birmingham Children's Hospital, hepatic transplantation services undertaken at the Queen Elizabeth Hospital, spinal surgery undertaken at the Royal Orthopaedic Hospital, or burns care undertaken at the Birmingham Accident Hospital. These services are funded as regional services by the West Midlands Regional Health Authority and children were not referred out of the region for these services during the study period. All other care was defined as general paediatric care.

The number of intensive care beds occupied by children on each day of 1991 was calculated

by taking the number of intensive care for the previous day, adding the number of admissions and subtracting the number of discharges for that day, and then adding the number of children both admitted and discharged on the same day. Data for children admitted in 1991 but discharged in 1992 were added to the January/February 1991 figures to compensate for children still receiving intensive care in early 1991 who had been admitted in 1990.

Population figures were obtained from the 1991 census. Patient flows were derived from the number of admissions to hospital for care by a paediatrician in each district, cross referenced by the patient's district of residence (finished consultant episodes data, West Midlands Regional Health Authority information department). These figures were for the financial year 1991-2, but are assumed to be applicable to the calendar year 1991.

Results

During 1991, 1033 children in 23 patient care areas were identified as receiving intensive care. Two hundred and ninety seven were resident in one of the four Birmingham health authorities (Birmingham residents). This population was analysed further.

There were 180 boys and 117 girls. One hundred and thirty three (45%) of the children were aged less than 1 year and 202 (68%) were aged less than 5 years (fig 1). The 1991 census reports 213 000 children resident in the study area of Birmingham, of whom 8% were aged less than 1 year and 36% less than 5 years.

One hundred and forty one (47%) Birmingham children in intensive care were admitted for specialist paediatric services and 156 (53%) for general paediatric care. Altogether there were 1.63 admissions per 1000 Birmingham boys and 1.07/1000 Birmingham girls in 1991.

Intensive care bed occupancy by Birmingham children varied from 0 to 11 beds, and was lowest in the summer and highest during the winter months (fig 2A). This variation was present for

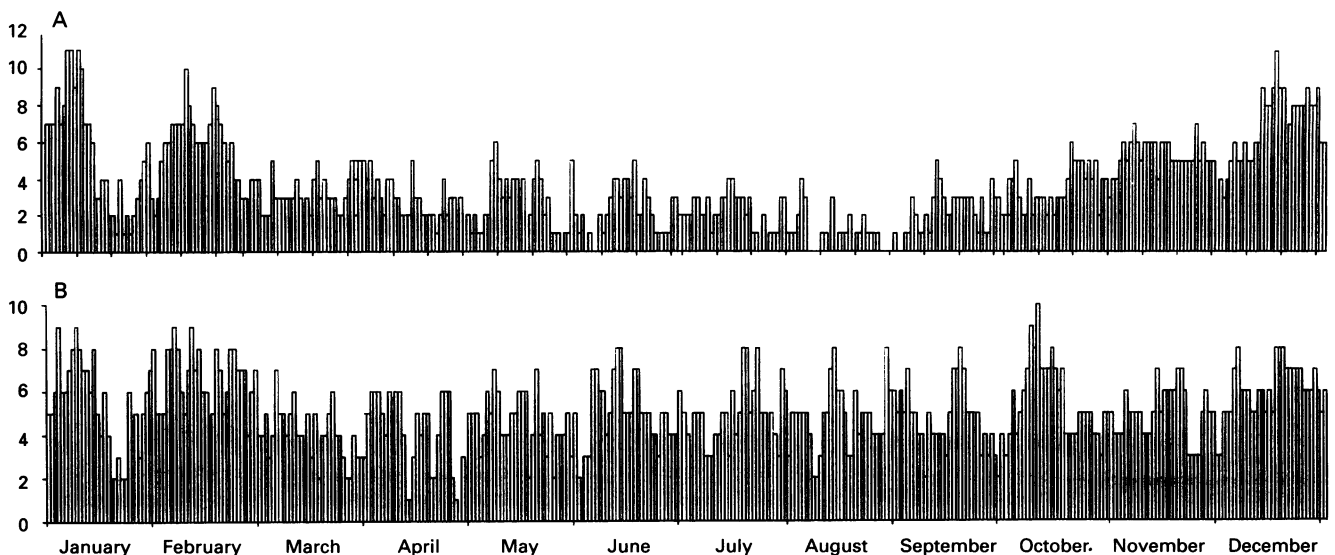


Figure 2 Intensive care bed occupancy. (A) Birmingham children, 1991 and (B) all children, specialist services, 1991.

Number of beds occupied each day in intensive care units by Birmingham children by number of days

No of beds occupied	No of days	Cumulative No of days
0	20	20
1	49	69
2	61	130
3	74	204
4	48	252
5	42	294
6	29	323
7	16	339
8	11	350
9	8	358
10	3	361
11	4	365

general paediatric patients, but was not seen for specialist children's services when data for all children treated by these services, irrespective of place of residence, were presented in the same way (fig 2B).

During the periods of peak demand, one in 19 000 Birmingham children were using intensive care facilities.

One hundred and six (68%) of the general paediatric patients were cared for in adult intensive care units, 46 (29%) in the paediatric intensive care unit, and four (3%) on a special care baby unit.

The table gives an aggregation of the bed occupancy, showing the number of days and the number of beds occupied on those days. Figure 3 shows this as a cumulative number and may be used to estimate how much of the year a specified number of beds would fulfil the demand.² To cover the demand for 95% of the year, one intensive care unit bed would be needed for every 26 000 children in the population.

The units did not only treat Birmingham residents. One hundred and nineteen children from outside Birmingham received intensive care in Birmingham hospitals for general paediatric disorders. Most of them (109 (92%)) were from elsewhere in the West Midlands. Forty seven (39%) were cared for in an adult intensive care unit, 70 (59%) in a paediatric intensive care unit, and two (2%) in a special care baby unit.

Crude mortality was 9% for all Birmingham patients, consisting of 10 deaths (7%) for

specialty patients and 18 deaths (12%) for general paediatric patients.

There were 21 deaths among children from outside the city who received intensive care in Birmingham hospitals (crude mortality 18%).

Children from outside Birmingham increased paediatric non-specialist use of intensive care by 70%, comprising 43% of general paediatric intensive care undertaken within Birmingham hospitals. Inconsistencies in local data for general paediatrics make comparisons difficult, but 5388 (32%) of 16 618 finished paediatric consultant episodes in Birmingham hospitals from whom the patient's district of residence is known relate to children from outside Birmingham (information department, West Midlands Regional Health Authority). The flow of children for intensive care appears to be similar to, but greater than, that for other paediatric services.

Discussion

These data show that the demand for paediatric intensive care is largely from very young children. The service is dominated by children under 5 years and particularly infants under 1 year of age. The technical skills required to care for these patients are clearly very different from adult services.

During the periods of peak demand in 1991, one in 19 000 Birmingham children were using intensive care facilities, a figure more than twice previous estimates.¹

There is a striking seasonal variation in the use of intensive care by children, with an 11-fold difference between lowest (summer) and the highest (winter) use. Most estimates of bed use are based on statistics which do not take into account variations in demand.² As these specialised facilities cannot be borrowed from other wards, provision must be made to cope with the busiest periods. Cumulative bed occupancy analysis may be used to address this problem.² To cover the demand for 95% of the year one intensive care bed is needed for every 26 000 children. This figure must be interpreted with caution as the data were collected during a period when we know that a lack of intensive care facilities limited use.

There was also a large influx of general paediatric intensive care from surrounding districts, which increased general paediatric intensive care undertaken within Birmingham hospitals by 70%. The mortality of these patients was almost twice that of Birmingham children. Proportionally more were treated in the paediatric intensive care unit, which implies that the unit is acting as a referral centre for more complex cases. These local considerations may limit the usefulness of our population based data in planning a particular units' bed requirements.

We have defined intensive care as admission to an intensive care unit or the use of procedures that we would not regard as routine on a general ward, a definition which has been used before.³ We have not looked at the severity of each child's illness and there is a risk of overestimating demand by including

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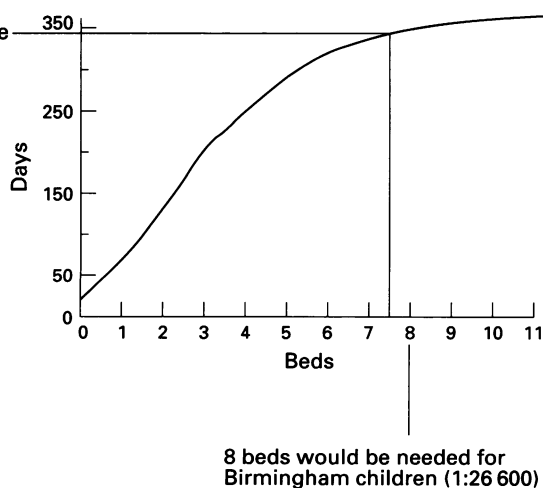


Figure 3 Intensive care bed occupancy by Birmingham children, 1991. Cumulative number of days that a certain number of beds were occupied.

children admitted inappropriately, so called inefficient intensive care unit use.⁴ We have previously shown, however, that the use by children of an adult intensive care unit in a Birmingham hospital is highly efficient.⁵ During the winter of 1991 there was difficulty in obtaining paediatric intensive care beds within the city, making it unlikely that children would be cared for on intensive care units unless really necessary.

It is more likely that we have underestimated demand as we may have missed children cared for on general paediatric wards. In all of the hospitals contacted, children were not cared for on general wards or associated 'high dependency areas' if undergoing mechanical ventilation, and only rarely if they had arterial lines or vasoactive drug infusions. Consultant paediatricians contacted in this study estimated that only a handful of children receiving such treatment might have been cared for on the paediatric wards. The only way to have identified these children would have been to review the medical notes of all children admitted to paediatric wards, which was not practical. We estimate that the errors in ascertainment are likely to be less than the biological variation in disease incidence.

The method of calculating bed occupancy could also overestimate demand, as patients admitted and discharged on the same day are assumed to use a full day. Conversely, it

assumes that there is no overlap between patient admissions and discharges on any particular day, an unrealistic assumption of what are often the most demanding periods of a patient's intensive care unit stay. Times of admission and discharge were not available for most patients in this study.

This study assesses use by children of intensive care, not need. We have no numbers for children refused admission to an intensive care unit, and no information on their fate, although we do know of some children waiting many hours for transfer to intensive care while a bed was being found. Need is clearly greater than the current provision. This paper provides some data to inform the debate on the development of intensive care services for children.

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