

Measuring neonatal nursing workload

Northern Neonatal Network

Abstract

A dependency scale has been devised for the assessment of the needs of neonates for nursing time. It has been validated by work studies which have shown that non-surgical babies can be grouped into one of two categories: high dependency babies generating a mean (SD) 25 (5) minutes and low dependency babies generating 12 (3) minutes of nursing work per hour, when the work is averaged out over the whole shift. Any one of five simple and unambiguous criteria serve as robust markers for identifying more than 95% of babies regularly generating more than 15 minutes of nursing work per hour. The scale is simpler, can be applied more rapidly, and with greater consistency, than other currently available neonatal dependency scales.

Additional allowance needs to be made for miscellaneous activity not attributable to individual babies, for the occasional baby who requires almost continuous undivided nursing attention, for the possibility of new admissions, and for the provision of an emergency interhospital transport service. A formula is suggested by which safe staffing levels for any given nursing shift can be determined, based upon the number of babies present and their dependency levels as determined by the scale.

(*Arch Dis Child* 1993; 68: 539-543)

Adequate nurse staffing levels are a fundamental prerequisite for satisfactory neonatal care. The standard of care will inevitably fall if the available number of staff is too low, but as nursing staff account for the largest single component of the cost of hospital care, it is important not to overestimate requirements.

By the early 1980s, the levels first recommended by the Chief Medical Officer's Expert Group in 1971¹ were widely regarded as inadequate, and several further national reports have subsequently appeared, with a variety of staffing recommendations and methods of defining dependency levels of neonates.²⁻⁹ The evidence on which these various schemes were based has not however been made public. A working party set up by Northern Regional Health Authority in 1982 to review the adequacy of neonatal care devised a relatively simple dependency scale, and commissioned a work study, both to validate this scale and to identify therefrom appropriate staffing levels. The findings of an initial study were published and endorsed by the regional health authority in 1984,¹⁰ and the dependency scale (hereafter called the 'NNN' (Northern Neonatal

Network) scale) has since been in widespread use throughout the region. That report, however, concentrated on the needs of units not undertaking 'intensive' neonatal care, and a further work study has since been performed to identify more precisely how much work is generated by high dependency babies.

The findings of these work studies have now been used to test further the validity of the dependency scale, to compare its practicability with other available scales, and to devise a method by which recording of dependency levels could be used to derive nurse staffing recommendations soundly based upon observable fact.

Methods

THE WORK STUDIES

A number of well validated techniques exist for measuring how much nursing work differing patients generate,¹¹ but these techniques do not seem to have been used to study workload in the neonatal period.

Informal in-house study: 1983

Observational records were kept, over a four hour period on 42 different occasions, of the nursing work generated by 132 babies in two units. These observations were performed over a six month period and included five weekend and eight night study periods.

Main study: 1989

This was a much larger, specially funded study, undertaken by organisation and management consultants. It was carried out over three separate 13.5 hour day periods and one 10.5 hour night period in each of four large neonatal units in the region. (Given an average cot occupancy of 14.2, this provided an estimated total of 2900 hours of patient care for analysis.) Work undertaken and generated by parents and by supernumerary students on attachment was included in the analyses. Each baby and each member of staff was watched continuously by an independent observer throughout the study period, and a record made of what was happening to each baby, and what each member of staff was doing once every five minutes using a work study approach similar to that adopted by those who drew up the Aberdeen work study formula for the Grampian Health Board.¹¹

Work was divided into the following categories:

(a) General nursing care:

(i) Basic care: this included tube and bottle feeding, the nursing care required routinely by well babies, and caring for parents and

Northern Neonatal Network, Northern Regional Health Authority

Correspondence to:
Miss Jill Pickering, Regional Maternity Survey Office, Princess Mary Maternity Hospital, Great North Road, Newcastle upon Tyne NE2 3BD.

Accepted 8 February 1993

No reprints available.

Table 1 Neonatal nursing dependency scale as currently used by the Northern Neonatal Network

Category	Criteria		
High dependency care	A 1. Babies currently receiving respiratory support (endotracheal, nasal, or facemask IPPV, IMV, or CPAP)		
	B 2. Babies currently requiring 40% oxygen or more 3. Babies whose whole fluid intake was provided intravenously in the previous 24 hours 4. Babies with a stoma or a pleural, peritoneal, or urethral drain in situ 5. Babies currently weighing less than 1000 g		
		C 6. Babies currently receiving some (but less than 40%) oxygen 7. Babies currently receiving some intravenous fluid 8. Babies at least partially tube fed in the past 24 hours 9. Babies who have had a fit or apnoeic attack (>20 sec) in the previous 24 hours	
			D 10. Babies currently weighing between 1000 g and 1750 g 11. Fully bottle or breast fed babies weighing more than 1750 g
Low dependency care			

Each baby is to be categorised by the first (that is the lowest numbered) defining condition. IPPV: intermittent positive pressure ventilation; IMV: intermittent mandatory ventilation; CPAP: constant positive airway pressure.

relatives. It included the type of care which could be undertaken by parents.

(ii) Technical care: this consisted of care which called for knowledge and expertise that could not be expected of a nurse who had not undergone postbasic subspecialty training. Activities in this category included the making of nursing observations, management of intravenous infusions, taking of blood and urine specimens, administration of drugs, and tasks involved in medical and nursing procedures.

(b) General ward work:

(i) Administrative work – for example completion of records, handover activity, ward rounds, teaching, stocktaking, time spent on the telephone, and with administrative staff.

(ii) Observational care – that is time spent at the main nursing station listening for alarms or other signs that a baby might need attention.

(c) Domestic work – for example cleaning, and changing linen.

(d) Miscellaneous activity – for example meal breaks and other time off the unit.

Time spent on (a) general nursing care was allocated to the individual baby receiving the care. Time devoted to (b(i)) administrative work and (c) domestic work could not be directly attributed to individual babies. It was therefore aggregated, and then divided between the babies in proportion to the amount of general nursing care each generated. Domestic work accounted for only 4% of nursing workload but administrative work away from the bedside took up almost as much time as family orientated and bedside care, and the most appropriate way of disaggregating this activity to individual patients remains uncertain. The approach adopted seemed reasonable to those involved in the study at the time (both those being observed and those responsible for the observations). Miscellaneous activity (d) consistently accounted for 18% of all nursing time (11 minutes per hour), but the amount of time spent providing observational care (b(ii)) varied inversely with cot occupancy.

Supplementary in-house study 1990–1

Observations were carried out in one unit over an 18 month period to identify the range of workload generated by ventilator dependent babies, and to define more precisely the

situations which seemed to require the almost continuous undivided attention of one nurse. A total of 141 ventilator dependent babies were studied on 572 occasions for a period of 4 hours on each occasion to identify how much bedside nursing care (and how much additional non-bedwise work) the management of these babies generated.

Further details of the observational data collected are available from the Regional Maternity Survey Office on request.

DERIVATION OF THE DEPENDENCY SCALE

The NNN scale was originally devised on the basis of the 1983 study and subsequently underwent minor modification in the light of experience of (table 1). It consists of 11 unambiguous criteria arranged hierarchically with conditions requiring the most nursing time at the top. Babies were classified according to the lowest numbered category which applied. The categories were subdivided into four dependency levels, A, B, C, and D. Categories A and B, were defined as high dependency categories, generating substantially more work than categories C and D, the low dependency categories. It seemed useful to identify babies receiving respiratory support (category A) separately from other high dependency babies, as in many other published dependency scales, because this is one index of dependency that is almost universally recorded and almost totally unambiguous. Category D babies were identified separately from other low dependency babies because, although they may be occupying a cot in a special care baby unit, they are not in reality receiving 'special' care.

Data from the 1989 work study was used to determine the distribution of nursing time required by babies in each of the 11 categories (table 2).

During the course of the organisation and management study, the opportunity was taken to examine the consistency with which staff allocated babies to work dependency grades using the original NNN scale as described in 1984,¹⁰ the British Paediatric Association (BPA) scale as specified for use with the statutory Körner Hospital Episode System Returns,⁴ and a prototype scale similar to that recently advocated by the British Association of Perinatal Medicine (BAPM).⁹ Medical and nursing staff familiar with the patients were asked to allocate babies into one of four dependency categories using each of these scales, and the consistency between staff members was calculated (table 3). A similar exercise was carried out when staff were asked to allocate babies retrospectively from casenotes (table 4).

Results

VALIDATION OF DEPENDENCY SCALE

In the 1983 and 1989 studies, 80% babies in categories A and B generated between 16 and 36 minutes of nursing work per hour, when averaged over a 12 hour period, and only 5% generated an average of less than 12 minutes per hour. The 1990/1 study identified a small

Table 2 Nursing workload generated by various types of nursing care. Work in minutes per hour, averaged over 4 hours, showing the 10th centile, median, and 90th centile. Time spent varies less widely when averaged over 12 hours (see text).

Category	Definition	No of 4 hour observation periods	Minutes of nursing work per hour (averaged over 4 hours)																			
			0	5	10	15	20	25	30	35	40	45										
A	1 Babies receiving respiratory support	104																				
	B	2 Babies in 40% or more inspired oxygen	56																			
		3 Babies receiving all their fluid and nutrition IV	72																			
		4 Babies with a stoma or drain <i>in situ</i>	15																			
		5 Other babies currently weighing under 1000 g	23																			
C	6 Babies in supplementary oxygen (<40%)	105																				
	7 Babies receiving some IV fluid in past 24 hours	96																				
	8 Babies at least partially tube fed in past 24 hours	441																				
	9 Recent (<24 hour) fit or apnoeic attack (<20 sec)	38																				
	10 Other babies currently weighing 1000–1750 g	109																				
D	11 Other totally breast or bottle fed babies	125																				

number of ill babies (less than 4% of all category A babies) who generated more than 35 minutes of nursing work per hour throughout the whole of one or more nursing shifts.

Of babies in categories C and D, only 5% generated more than 15 minutes of work per hour over a 12 hour period. In these 'low dependency' categories, only three babies were found who needed more than 20 minutes care per hour for several days: one was a preterm baby with congestive cardiac failure and Down's syndrome, the second was a baby with severe recurrent apnoea and seizures resulting from posthaemorrhagic hydrocephalus, and the third had tracheomalacia after surgery for tracheo-oesophageal fistula.

The distribution of nursing time generated by babies allocated by each of the 11 defined criteria is shown in table 2. Empirical testing, using the data available, suggested that the addition of further criteria added little to the efficiency with which the system identified babies requiring a lot of nursing attention. Babies undergoing major medical procedures such as arterial catheterisation or exchange transfusion generated a lot of work for a short period, but this intensive requirement seldom lasted for more than 60–90 minutes. Phototherapy (included in the BPA and BAPM classifications as a criterion of 'special care') did not generate any measurable additional nursing activity, while the amount of time required to support a mother breast feeding a preterm baby regularly exceeded that given to a baby requiring regular biochemical monitoring or medication.

No reference has been made to babies with surgical conditions, because the professional organisation and management study did not include data from the region's surgical and cardiothoracic centres.

CONSISTENCY OF ALLOCATION

Using the NNN scale, staff allocated babies with greater consistency than when using either the standard 1985 BPA scale⁴ or a prototype of the 1992 BAPM scale.⁹ This was true both prospectively when staff were caring

Table 3 Consistency (in %) with which different unit staff prospectively classified the dependency of individual babies on a daily basis using different scales*

Classification	Category			
	A	B	C	D
NNN scale ¹⁰	100	97	98	99
BPA scale ⁴	98	79	83	91
BAPM scale ⁹	89	87	93	92

*Concordance assessed on 264 occasions in four different units.

†A prototype version of the 1992 classification.

Table 4 Consistency of a retrospective assessment of dependency from the casenotes using different scales*

Classification	Category		Time taken to review notes (min)
	A or B	C or D	
NNN scale	98%	99%	16
BPA scale	86%	91%	27
BAPM scale	84%	90%	34

*Records for the first 20 days of life from 25 babies from five different units independently assessed by five different people.

Table 5 Influence of staffing levels on the amount of direct nursing care given to babies during the day (data from the 1989 organisation and management study)

Unit	Nurses per patient			Time spent giving care (min/hour)†	
	All staff including students	Established staff only	Unallocated nursing time*	High dependency babies	Low dependency babies
1	0.70	0.54	22%	26.7	17.8
2	0.52	0.46	23%	22.5	15.2
3	0.50	0.39	18%	26.2	13.1
4	0.36	0.32	14%	23.7	12.8

*Nursing time not allocated to the care of any particular patient excluding administrative ward work (see text), statutory meal breaks, and other time off the unit.

†Care given by the nurses and the parents.

for the baby (table 3), and retrospectively when staff were given the notes of an unfamiliar patient to review (table 4) irrespective of which scale staff were most familiar with. The NNN scale was also applied more quickly when used retrospectively. As many as 26% of babies identified as requiring high dependency care using the 1985 BPA scale, and 21% of babies identified using the 1992 BAPM scale, did not actually seem to be generating an average of more than 15 minutes of nursing work per hour, but this was only true of 8% of babies categorised as requiring high dependency care using the NNN scale.

THE EFFECT OF DIFFERING STAFF LEVELS

Cot occupancy was not particularly high during the 1989 study and varied between the four units studied (table 5). The amount of time spent with the low dependency babies increased as staffing levels rose, but there was no consistent increase in the amount of time spent with high dependency babies. It is doubtful if this would have been the pattern of behaviour seen had staff felt that the high dependency babies were receiving inadequate care.

Discussion

In drawing up a dependency scale it is essential to have a clear objective. Thus a scale could be drawn up reflecting the gravity of a child's illness, the technical complexity of the care required, or the amount of nursing work generated by a child's care. In some scales an attempt seems to have been made to address all three objectives simultaneously. The NNN scale described here was designed primarily to address the third of these alternatives, and seems to have produced a classification which is simpler, and easier to apply consistently, both at the cot side (table 3) and retrospectively (table 4), than most.

Although four dependency categories, A, B, C, and D, are defined, for most purposes a division into two groups, high dependency (A and B) and low dependency (C and D) is quite adequate. The work generated by category B babies was very similar to that generated by category A (ventilator dependent) babies; likewise, babies in category D required a similar amount of nursing time to those in category C (table 2). On average, high dependency babies required approximately twice as much time as

those of low dependency. The division between high and low dependency groups is the most clear cut in terms of required nursing time, and more important than whether a baby is actually receiving respiratory support.

The term 'neonatal intensive care' has become subject to a wide variety of interpretations¹⁰ and is now therefore of questionable value. It is suggested that the concept of 'high dependency neonatal care', as defined by the NNN scale, being based on clear, validated criteria, is of greater relevance in determining resource implications.

Certain important conditions, such as infection, convulsions and 'recurrent' apnoea, and various complex forms of treatment, such as 'total' parenteral nutrition, have not been included in the criteria of the NNN scale. This is because it is vital that any dependency scale should be based on criteria that can be defined in a precise and unambiguous way. We do not believe that this has been achieved with either the original 21 point BPA scale⁴ or the new 32 point BAPM scale,⁹ where some of the definitions, such as the examples cited above, are open to more than one interpretation.

It is also important that, as far as possible, a dependency scale should reflect only what a baby actually needs, not merely what is given. For example, units vary widely in the extent to which they use total parenteral nutrition for babies no longer receiving respiratory support: a scale that used total parenteral nutrition as a marker might be easily misinterpreted as showing that one unit had more ill babies than another. While there is no complete solution to this dilemma the criteria defined in table 1 were selected to minimise the problem. We suspect nevertheless that there is a considerable variation in the way that units perceive babies as 'needing' tube feeding, which affects the allocation of babies between categories C and D. Fortunately, there are few problems in deciding whether a particular baby is in category B or C, which is the division which has the most significant impact on staffing requirements (see below). The same cannot be said of the 1985 BPA scale, as a study in the Trent region has already highlighted.¹²

It is recognised that many babies intermittently demand the almost undivided continuous attention of an experienced nurse for two or more hours, and routine staffing levels need to be flexible enough to cope with such fluctuations in need. There are however a few babies who may require such continuous care for several hours, and on occasion for more than a whole shift. The circumstances leading to such a need are difficult to define precisely, but easy to recognise in practice. Future experience may show that babies requiring dialysis or extracorporeal membrane oxygenation all require continuous individual care. The arrival on a unit of a particularly sick baby may transiently generate the same intensity of nursing work, as may the preterminal care of a dying child and its family. It may be helpful to designate these babies as 'category A+' when defining the adequacy of the staffing levels for a particular nursing shift. Such episodes are,

however, unlikely to occur sufficiently frequently to require documentation when monitoring annual workload and its implications for unit nursing establishment.

The staffing burden imposed by the provision of an emergency neonatal 'flying squad' also requires recognition. Instead of incorporating such activity in the dependency scale, we suggest it is preferable to record this separately, with a view to making a case for an addition to the establishment of units regularly providing such a service.

STAFFING IMPLICATIONS

It has been traditional to define the staffing requirement of a unit by cot numbers, but, as the Northern region's 1984 report argued,¹⁰ it is babies, not cots, that generate work. Since 1984 the neonatal unit staff allocations for district hospitals recommended by the Northern Regional Health Authority have been based on each hospital's annual delivery rate. A different formula is however necessary for centres undertaking a significant amount of high dependency care.

The results presented here show that while low dependency babies generate an average of 12 minutes of nursing activity per hour, most high dependency babies generate an average of 25 minutes per hour, and nurses spend an additional average of 11 minutes per hour on 'miscellaneous' (but necessary) activity. It is therefore suggested that one nurse can care for four low dependency (category C or D) babies, two high dependency (category A or B) babies (or one extreme high dependency (category A+) baby):

Low dependency: 4 babies @ 12 min each + 11 mins = 59 min

High dependency: 2 babies @ 25 min each + 11 mins = 61 min

To determine the number of nurses required to look after the occupants of a neonatal nursery at any time, therefore, count the number of low dependency babies, add to this twice the number of high dependency babies, and divide the total by four. To this needs to be added an allowance to cope with possible new admissions (no unit should ever plan to operate at full capacity), and, in units providing such a service, the possibility of the need for a supervised interhospital transfer.

Calculations show that a unit needs to have approximately 5.7 nurses in post to provide one nurse on duty at any one time.¹³ This figure can rise even further if there is no separate budgetary provision for statutory maternity leave, secondment for postbasic training, and long term sickness. Calculating the number of staff required on duty to cope

with all but 1 or 2% of a unit's annual workload peaks¹³ and multiplying by this factor of 5.7 provides a realistic formula for defining the required staffing establishment. The recommendations thus derived may prove to be lower than those suggested in several recent reports,^{5,7,9} but they are based on hard, objective data.

Such an approach leads to the recognition that cot occupancy figures are not a very sensible way of monitoring either the economic efficiency or the clinical safety of a unit. Safety must always be the overriding priority. If it is the existence of a safe staffing level, and not the number of cots or ventilators on a unit that finally determines both individual shift capacity and annual workload, then it is the number of nurses available on each shift, and their expertise, that needs to be documented and matched against patient numbers and their dependency status.

This report summarises the outcome of eight years of consultation and joint endeavour by clinicians throughout the Northern region: its conclusions have been incorporated into the third report on neonatal services in the Northern region which was published by the Northern Regional Health Authority in December 1992. Work study data collected by the regional health authority organisation and management unit in 1989 was provided by Mr B Mackley of Newcastle's Newcare Management Consultancy Services.

Nurses from the five main referral units in the region (Miss M Beattie, Mrs M Burt, Miss B Harrison, Miss J Pickering, and Mrs S West) drew up the final report with Dr A J Cottrell and Dr E N Hey.

- 1 Department of Health and Social Services. *Report of the expert group on special care for babies*. Report on Public Health and Medical Subjects No 127. London: HMSO, 1971.
- 2 Royal College of Midwives. *Recommendations of the working party on staffing levels (hospitals)*. London: Royal College of Midwives, 1980.
- 3 Standing Committee of the British Paediatric Association and the Royal College of Obstetricians and Gynaecologists. *Midwife and nurse staffing and training for special care and intensive care of the newborn*. London: Royal College of Obstetricians and Gynaecologists, 1983.
- 4 British Paediatric Association and British Association for Perinatal Paediatrics. *Categories of babies requiring neonatal care*. *Arch Dis Child* 1985; **60**: 599-600.
- 5 English National Board for Nursing, Midwifery and Health Visiting. *Guidelines on the staffing of neonatal units*. London: English National Board, 1987.
- 6 Neonatal Nurses Association. *Comments on ENB guidance document on guidelines to staffing of neonatal units*. Nottingham: Neonatal Nurses Association, 1987.
- 7 Royal College of Physicians. *Medical care of the newborn in England and Wales*. London: Royal College of Physicians, 1988.
- 8 English National Board for Nursing, Midwifery and Health Visiting. *Guidelines for staffing of neonatal units involved in ENB courses*. London: English National Board, 1991. (Circular No 1991/09/APS.)
- 9 Report of 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 Northern Regional Health Authority. *Second report on neonatal services in the Region*. Newcastle: NRHA, 1984.
- 11 Bright JA. *A critique of methods for determining nurse staffing levels in hospital*. (ORZ1051.) London: DHSS Operational Research Service, 1985.
- 12 Field DJ, Hodges S, Mason E, Burton P, Wale S. The demand for neonatal intensive care. *BMJ* 1989; **299**: 1305-8.
- 13 Northern Neonatal Network. Requirements for neonatal cots. *Arch Dis Child* 1993; **68**: 544-9.