0303-8408/95/060361-08 $ 1.50 + 0.20/0

Soz Präventivmed 1995; 40: 361–368

Miranda Mugford

National Perinatal Epidemiology Unit, Radcliffe Infirmary, Oxford

The cost of neonatal care: Reviewing the evidence

Results of studies conducted nearly twenty years ago in Canada and the USA are still cited in comparisons of cost-effectiveness of alternative forms of health care. There are considerable geographical variations in the type and amount of service for neonatal care and many changes have occurred in the provision of care in most industrialised countries over that time. So it is reasonable to ask whether the results of the early studies are relevant now. In this paper, I present some evidence from a review of the research literature on the costs and economics of neonatal care.

Definitions and terminology

Throughout this paper, I refer to terms that are often disputed in meaning. I will use the term neonatal intensive care unit (NICU) to refer to a unit providing care including artificial ventilatory support for newborn babies. Units can be designated as they are in the USA and in Australia, as level I, II, and III. In the UK this designation is not formalised.

The care provided in a neonatal unit is sometimes recorded on a daily basis in order to estimate workload at different levels of intensity of care, usually to predict nursing and other resource needs. The way that this division is made varies from place to place, but a common division in the UK is between intensive care and special care. Intensive care is care requiring one to one nursing care including assisted ventilation, and care on the days following major surgery, and special care is all other care in the neonatal unit. Because the special care category is so variable in terms of need, there are many subdivisions with different names and varying definitions.

Economic studies can include any that measure costs, but an economic evaluation is one which compares costs and outcomes for two or more alternative forms of care[1]. Different forms of economic evaluation include cost-effectiveness, cost utility and cost-benefit analysis. The principal aim of economic evaluation is to provide evidence for a choice between alternative forms of care. Choices could be, for example, whether or not to provide intensive neonatal care at all for a population or subgroup or whether increased access to intensive care should be provided either within a unit by adding facilities or geographically by changing referral policies and or transport services.

In economics, cost is the value of the change in resources resulting from the new form of care. Costs may be incurred by health sector and by patients and others. Costs may arise during the intervention being evaluated or as a result. Some important resources have no market value, for example, voluntary help. Market prices, such as hospital charges or commercially published drug prices, are not always a good guide to economic costs.

Methods for the review

My aims in reviewing the literature on the costs and economic value of neonatal care have been: to identify as many studies as possible of costs or economic impact of relevant forms of care for newborn babies; to classify studies by the topic they evaluate and the type and method for evaluation; to assess how differences in study method, country, year of study, characteristics of participants, and health care setting are related to differences in cost estimates; and to summarise and critically assess the evidence about the costs and economic efficiency of specific forms of care, taking account of research quality[2]. I have not considered here the important epidemiological literature relating infant mor-

tality and access to obstetric and neonatal care.

The searches for research studies aimed to identify as many relevant studies as possible, including unpublished work. Literature searches included studies reported in the years from 1970 onwards. Searches for 1993 and 1994 are incomplete. Studies in English and French were included, and English abstracts for German, Danish, Swedish, and Norwegian studies were reviewed for possible translation. Studies on insurance and financing aspects of perinatal care services, and on the equity of provision are excluded. In order to minimise selection bias in the review, we looked at as many sources as possible, because no databases or catalogues cover the whole range of relevant research[3]. Search terms and databases searched are shown in Appendix A.

Results of the searches

The process of searching for relevant papers continues, but to date we have identified 181 reports of studies of the economics of neonatal care (Table 1). The number by year of publication (or of the report where the study is not published) has increased annually, and exponentially. I have looked in detail at those studies we identified which were on the subjects either of the economics of neonatal intensive care and care of preterm infants or of the economics of prevention and treatment of RDS.

There were 76 reports of the economics of NICU, of which 29 were reports of primary research studies on the costs or economics of care. And 34 reports of the economics of prevention and treatment of RDS, of which 23 were reports of primary research studies on the costs or economics of care. The remaining reports included abstracts, reviews, discussion papers and studies excluded on grounds of quality of research. The bibliography of these reports is in Appendix B. Although I concentrate here on NICU and RDS costs, there is a diverse range of economic and cost studies in the field, covering issues from the use of napkins to neonatal ECMO and infant transport.

Results of the review of NICU costs

The 29 cost studies come from many countries, but most from the USA, Australia and the UK. Studies may have different cost estimates because of differences in currencies and price levels, differences in the method used for cost estimation, and differences in the groups of babies studied, among other factors. Because the studies were done in different places and at different times, the price levels are not comparable. I have adjusted all prices to 1994 UK values using the average exchange rate between the local currency and £sterling for the year of the study, and retail price inflation for the UK since that year.

I have grouped the studies into groups by method of costing (Table 2). The methods vary in the degree to which they include capital and training costs, and other overheads, not directly related to care of an individual baby. The method of costing varies by country of research: charges are often used where such data are routinely available, as in the USA. Even where they are available, they do not represent costs very well. The most common alternative approaches are based on cost accounting methods, either using detailed information about resources used by individual patients ("bottom up"), or by allocation of total costs by unit workload ("top down"). Studies also vary in the degree that they take account of costs (and outcomes) beyond the neonatal unit. I have concentrated on the reported NICU costs here, but a full evaluation should include all costs.

Year of publication	Number of studies NICU and preterm	RDS and surfactant	other	all
1974–1978	1	–	2	3
1979–1983	12	–	2	14
1984–1988	31	–	12	43
1989–	32	34	54	120
All	76	34	71	181
Included in review	29	23	–	–

Table 1. *Studies of costs or economics of neonatal care.*

		Number of studies
A	Unadjusted health care charges	6
B	Adjusted health care charges	3
C	"Bottom up" costing	16
D	"Top down" costing	3
E	Imputed costs from utilisation	1
	Total	29

Table 2. *Methods for costing.*

Population	1994 Prices £ UK			
	Number of studies	Mean cost	95 % CI low	high
< 1000 g	18	20,398	14,500	26,300
1000–1499 g	12	13,500	8,500	18,500
All admissions	10	10,900	4,400	17,400

Table 3. *Neonatal care: cost per case.*

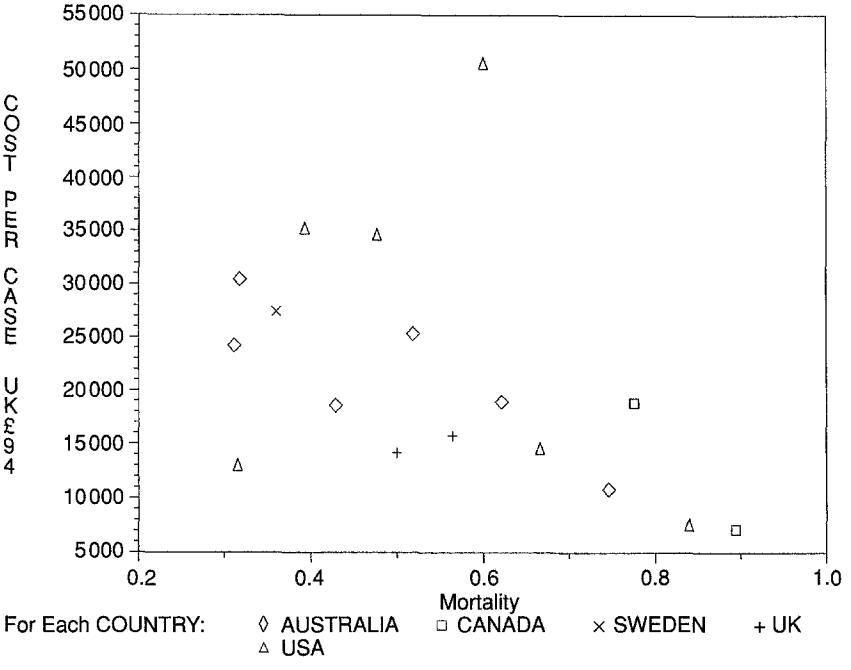

Figure 1. *Neonatal care cost per case < 1000 g by mortality rate.*

Although there are many reasons to be cautious about comparisons between studies, I have summarised the estimates that different studies have made of the costs of care in the neonatal unit. Having found so many reasons why estimates of costs might not be comparable, it is surprising to find consistent evidence from the cost data. Ten studies estimated overall costs for admissions to NICU, 12 estimated costs for babies with birthweights between 1000 and 1500 g, and 18 estimated costs for extremely low birthweight (ELBW) babies (<1000 g). Very few studies have estimated costs by gestation or disease group, although there have been some studies from the USA[4], and from Australia[5].

The overall average cost per case in a neonatal unit is very high, by comparison with normal newborn care. Although the confidence intervals are very wide, it is apparent that average cost per case increases for babies in lower birthweight groups (Table 3). Given the variability in neonatal unit populations, the variation in costs within each group is not surprising.

Variation in neonatal care costs is also related to mortality. Some studies estimated costs separately for babies who died, and the estimates for ELBW babies show that the cost is usually higher for survivors than for those that die. But cost estimates are still very variable between studies. The consequence of this is that as survival increases, so do average costs of care for very small babies. Figure 1 shows the results for costs per case less than 1000 g compared to the mortality rate for that group in each study.

In addition to the estimates of costs per case, daily costs of different levels of NICU care are reported in a large proportion of the studies reviewed (Table 4). Here the evidence has to be interpreted with care. The studies giving average

Level of care	1994 Prices £ UK Number of studies	Mean cost per day	95 % CI lower	higher
Intensive	15	550	464	637
High dependency	8	343	280	407
Special	14	205	172	237
All NICU	13	569	355	783
USA	6	841	487	1195
not USA	7	335	21	457

Table 4. *Costs of daily neonatal care by level.*

daily costs in NICU include many US studies. These usually show higher costs than are reported in other parts of the world, partly because of the costing methods used. The studies from countries other than the USA show a very much lower average cost per day. Studies reporting costs by *level* of care are from Europe and Australia, but not from the USA. These show a consistent pattern of higher costs for days of intensive care than for less intensive care. The ratios between cost estimates within studies for intensive and special care, and for care of babies of 1000–1499 g and below 1000 g birthweight are stable, over time and between countries, including those studies that used charges as a basis for cost estimation.

Evidence of economic benefit of NICU care

Although I have reviewed 29 studies of the costs of neonatal care, most were observational studies of the costs of care. Only five studies were economic comparisons of costs and benefits. These studies are of variable quality, one study from Canada by Boyle and colleagues[6] stands out, and is frequently cited in the health economics literature as a good example of a health economic evaluation. This, and a study from Australia by Kitchen and colleagues[7], are based on outcomes for population based cohorts before and after access to neonatal intensive care was expanded. The results for the additional NICU costs per additional survivor at discharge under 1000 g (adjusted to 1994 UK costs) of just over £ 100000, are surprisingly similar given the distance in time and place between the studies. The Canadian study also compared the costs for bigger babies, and showed that the cost for an additional survivor was about half that for the smaller babies. When they took account of discounted long term costs and outcomes this differential was much greater.

Studies that attempted to weigh up the overall lifetime social costs and benefits on NICU care[7,8], using cost-benefit analysis methods, have concluded that there would be a net economic loss for babies of less than 1000 g, but that NICU care could provide a net gain for bigger babies. A further abstract from Norway[9] reported a net economic gain overall from neonatal intensive care. The results of these cost benefit studies have been contentious, partly because of the method for valuing the benefits of survival. This was done by estimating the long term care costs and potential earnings of survivors, which are not necessarily a good measure of social costs and benefits. Even if they are, the studies were based on very limited information about the life expectancy and long term disability for low weight survivors, and about likely lifetime care needs and earning patterns.

Result of the review of economic impact of prevention of RDS

Another problem with the economic evaluation studies is that most were conducted over ten years ago. The commonest reason for neonatal intensive care in preterm babies is that they have immature lungs. Two treatments have been introduced that have been demonstrated to improve outcomes for these babies: antenatal corticosteroids, and exogenous surfactant. Surfactant might increase costs because it is an expensive product and to increases survival but it reduces severity of RDS and therefore could also reduce costs. Table 5 shows the results of economic evaluations of surfactant used as a treatment for established RDS. It may have a neutral effect on costs, and possible lead to reduced costs, especially in bigger babies with RDS. Interventions to prevent RDS can reduce overall costs of neonatal care, in the case of antenatal corticosteroids, but, in the case of surfactant given prophylactically, can increase overall costs. Recent trials comparing early with delayed surfactant treatment favour early use. If this is the choice, there may be an additional cost per additional survivor.

Conclusions

I have not done justice to the considerable amount of research that

	Study	Country	£ UK 1994
Surfactant treatment for RDS			
Preterm	Tubman 1990	UK	8,666
700–1350 g	Mammel 1991	USA	27,077
> 1350 g	Schumacher 1991	USA	net saving
> 650 g	Phibbs 1993	USA	no difference
> 1250 g	Backhouse 1994	USA	net saving
700–1350 g	Mauskopf 1995	USA	no difference
Antenatal steroids			
< 35 weeks	Mugford 1991	UK	net saving
< 31 weeks	Egberts 1992	Netherlands	net saving
Prophylactic surfactant			
700–1100 g	Sell 1991	USA	51,550
< 35 weeks	Mugford 1991	UK	13,495
700–1350 g	Phibbs 1993	USA	69,460
< 1500 g	Virtanen 1993	Finland	42,800
< 1500 g	Schwartz 1994	USA	133,900

Table 5. *Economic benefit of prevention and treatment of RDS Additional cost per additional survivor.*

has been reported on the costs and economics of neonatal care. However, I can draw a few conclusions from this review. In spite of difference in methods, there is consistency between studies in the picture of the cost of providing neonatal care, and the relationship between costs for different groups of babies. I have reported the costs for very low birthweight babies requiring intensive care. Several authors have commented that more than half the workload in a neonatal unit is taken up by care of bigger babies and recovering survivors of neonatal intensive care. There is very little evidence about the costs of care of these babies, especially those that do not require intensive care or surgery. There is, however, increasing interest in the question of appropriate admission and discharge policies for NICUs. I have shown that the economics of NICU care may have been changed by the introduction of surfactant and by the wider use of antenatal corticosteroids.

Appendix A

Search strategies for economic studies of neonatal care

Free text searching

Economics: *economic*, cost, costs, *expenditure*; Neonatal & care: neonat*, newborn, neonatal intensive care*, perinat*, SCBU, special care*, *low birthweight, premature*, preterm, NICU, fetus, foetus

Relevant MeSH TERMS

(economics (don't explode) OR economic value of life OR economics, hospital OR economics, medical OR economics, nursing OR costs and cost analysis)
and
(infant, newborn (explode, all subheadings) OR infant care (explode, all subheadings) OR nurseries, hospital OR intensive care units, neonatal OR maternal-child nursing OR perinatology OR neonatology OR fetus)

Databases on CD-ROM or through online connections medline
Healthplan
Excerpta medica
Arts and Humanities
Social Science Citations
Science Citations

Appendix B

References to studies of the costs and economics of neonatal intensive care

1. Included in review

Boyle MH, Torrance GW, Sinclair JC, Horwood SP. Economic evaluation of neonatal intensive care of very-low-birthweight infants. N Engl J Med 1983; *308*:1330–1337.
Connolly M, Fox G, O'Connor G, Clarke TA, Matthews TG. Cost of neonatal intensive and special care. Irish Med J Feb 1989; *82*:34–36.
Doyle LW, Murton LJ, Kitchen WH. Increasing the survival of extremely immature (24- to 28-weeks gestation) infants – at what cost? Med J Aust 1989; *150*: 558–568.
Ewald U. What is the actual cost of neonatal intensive care? Int J Technol Assess Health Care 1991; *7*:155–161.
Fordham R, Field DJ, Hodges S, Normand C, Mason E, Burton P, et al. Cost of neonatal care across a health authority. J Publ Health Med 1992; *14*:127–130.
Hughes B. A review of charges for neonatal care and the cost of establishing an additional intensive care cot [Dissertation], 1993.
Immershein AW, Turner C, Wells JG, Pearman A. Covering the costs of care in neonatal intensive care units. Pediatr 1992; *89*:56–61.

John E, Lee K, Li GM. Cost of neonatal intensive care. Aust Paed J 1983; *19*:152–156.
Kaufman SL, Shepard DS. Costs of neonatal intensive care by day of stay. Inquiry 1982; *19*:167–178.
Khadilkar VV, Tudehope DI. Cost analysis of extremely low birth weight infants: an update. J Paed Child Health 1992; *28*:410.
Kitchen WH, Bowman E, Callanan C, Campbell NT, Carse EA Charlton M, et al. The cost of improving the outcome for infants of birthweight 500–999 g in Victoria. J Paed Child Health 1993; *29*:56–62.
Malan A, Ryan E, Van der Elst C, Pelteret R. The cost of neonatal care. South Afr Med J 1992; *82*: 417–419.
Marshall PB, Halls HJ, James SL, Grivell AR, Goldstein A, Berry MN. The cost of intensive and special care of the newborn. Med J Austr 1989; *150*:568–574.
Mascall A. The cost of living [Dissertation], January 1988.
Meberg A. Cost-benefit analysis of neonatal care. Ped Res 1988; *24*: 271.
Monset-Couchard M, Jaspar ML, De Bethmann O, Relier JP. Cout de la prise en charge initiale des enfants de poids de naissance inferieur ou egal a 1500 g en 1981. Arch Fr Pediatr 1984; *41*: 579–585.
Newns B, Drummond MF, Durbin GM, Culley P. Costs and outcomes in a regional neonatal intensive care unit. Arch Disease in Childhood 1984; *59*:1064–1067.
Pharoah POD, Stevenson RC, Cooke RWI, Sandhu B. Costs and benefits of neonatal intensive care. Arch Disease in Childhood 1988; *63*:715–718.
Phibbs CS, Phibbs RH, Pomerance JJ, Williams RL. Alternative to diagnosis related groups for newborn intensive care. Pediatr 1986; *78*:829–836.
Phibbs CS, Williams RL, Phibbs RH. Newborn risk factors and costs of neonatal intensive care. Pediatr 1981; *68*:313–321.
Pomerance JJ, Ukraniski CT, Ukra T, Henderson DH, Nash AH, Meredith JL. Cost of living for infants weighing 1000 grams or less at birth. Pediatr 1978; *61*: 908–910
Ryan S, Sics A, Congdon P. Cost of neonatal care. Arch Disease in Childhood 1988; *63*:303–306.
Sandhu B, Stevenson RC, Cooke RWI, Pharoah POD. Cost of neonatal intensive care for very-low-birthweight infants. Lancet 1986; *1*:600–603.
Walker DB, Feldman A, Vohr BR, Oh W. Cost-benefit analysis of neonatal intensive care for infants weighing less than 1000 grams at birth. Pediatr 1984; *74*:20–24.
Walker DB, Vohr BR, Oh W. Economic analyis of regionalized neonatal care for very low-birthweight infants in the state of Rhode Island. Pediatr 1985; *76*: 69–74.

2. Excluded from review

Bell RE, Ackerman NB, Yoder BA, Null DM, deLemos RA. Military neonatal transport and intensive care – effective and cost effective. Milit Med 1984; *149*:143–145.
Bose CL, La Pine TR, Jung AL. Neonatal back-transport – cost-effectiveness. Med Care 1985; *23*: 14–19.
Brooten D, Kumar S, Brown LP, Butts P, Finkler SA, Bakewell-Sachs S. A randomized clinical trial of early hospital discharge and home follow-up of very-low-birthweight infants. N Engl Med 1986; *315*:934–939.
Chaikind S, Corman H. The impact of low birthweight on special education costs. J Health Econom 1991; *10*:291–311.
Couriel JM, Davies P. Costs and benefits of a community special care baby service. Br Med J 1988; *296*:1043–1046.
Edell DS, Banton DL, Browning IB. The financial impact of the high technology newborn. North Carolina Med J 1991; *52*:97–99.
Furlong A. Hospital buyers mull over high frequency ventilators. Hospital Materials Management 1991; *16*:2–9.
Giacoia GP, Rutledge D, West K. Factors affecting visitation of sick newborns. Clin Pediatr 1985; *24*: 259–262.
Jacob J. Cost savings of regionalized perinatal care for low birth weight infants: part I. Cost of hospitalisation and morbidity. Alaska Med 1986; *28*:42–46.
Jacob J. Cost savings of regionalized perinatal care for low birth weight infants: part II. Cost of hospitalisation and morbidity. Alaska Med 1986; *28*:53–56.
John E, Abelson P, Roberts V, Roberts S. Cost of neonatal intensive care, 1993.
John E. Perinatal services and the extremely low birthweight infant. The Medical Journal of Australia 1983; *2*:302.
John E, Hind N, Roberts V, Roberts S. Cost efficiency of neonatal nurseries: the significance of unit size. Austr J Publ Health 1991; *15*: 242–244.
Jung AL, Bose CL. Back transport of neonates: improved efficiency of tertiary nursery bed utilization. Pediatr 1983; *71*:918–922.
Lewis J. Costing neonatal care: a project at Addenbrooke's Hospital, Cambridge, 1994.
Lindsay SM. Neonatal intensive care (provisons and costs). Intensive Care J 1986; *1*:204–209.
McCormick MC, Bernbaum JC, Eisenberg JM, Kustra SL, Finnegan E. Costs incurred by parents of very low birth weight infants after the initial neonatal hospitalization. Pediatr 1991; *88*: 533–541.
Murton LJ, Doyle LW, Kitchen WH. Care of very low birthweight infants with limited neonatal intensive care resources (review). IME Bulletin 1987; *1*:3–4.
Naylor MD, Brooten D, Brown L, Borucki LC. Institutional yield on research: a case study. Nursing Outlook 1991; *39*:166–169.

Newns B. Costs and outcomes in a regional neonatal intensive care unit. Arch Disease Childhood 1984; *59*:1064–1067.
Phibbs CS, Mortensen L. The cost effects of back transporting infants from neonatal intensive care units to community hospital for recovery care. Pediatr 1992; *90*:22–26.
Pinney MA, Cotton EK. Home management of bronchopulmonary dysplasia. Pediatr 1976; *58*: 856–859.
Saxe JS, Edell DS. Resource-based relative value scale (letters). North Carolina Med J 1991; *52*:233–235.
Seay RE, Edgren BE, Schilling CG. Cost avodance using syringe pumps to administer fat emulsion in a neonatal intensive-care unit. Am J Hosp Pharm 1991; *48*:1972–1974.
Shankaran S, Cohen SN, Linver M, Zonia S. Medical care costs of high-risk infants after neonatal intensive care: a controlled study. Pediatr 1988; *81*:372–378.
Smith MA, Baum JD. Costs of visiting babies in special care baby units. Arch Disease Childhood 1983; *58*:56–59.
Stevenson RC, Pharoah POD, Cooke RWI, Sandhu B. Predicting costs and outcomes of neonatal intensive care for very low birthweight infants. Public Health 1991; *105*:121–126.
Walker DJB, Feldman A, Vohr BR, Oh W. Neonatal intensive care – cost benefit analysis (letter – reply). Pediatr 1985; *75*:799–800.

References to studies of the costs or economics of policies for prevention or treatment of respiratory distress syndrome

1. Included in review

Backhouse ME, Mauskopf JA, Jones D, Wold DE, Schumacher R, Long WE. Economic outcomes of calfosceril palmitate rescue therapy in infants weighing 1250 g or more with respiratory dishes syndrome: Results from a randomized trial. Pharmacoeconomics 1994; *6*:358–369.
Egberts J. Department of Obstetrics and Gynaecology. Theoretical changes of the costs of hospitalization of neonates after the introduction of the surfactant Curosurf. Forthcoming September 1994.
Egberts J. Estimated costs of different treatments of the respiratory distress syndrome in a large cohort of preterm infants of less than 30 weeks gestation. Biol Neonate 1992; *61*:59–85.
Maniscalco WM, Kendig JW, Shapiro DL. Surfactant replacement therapy: impact on hospital charges for premature infants with respiratory distress syndrome. Paediatr 1989; *83*:1–6.
Mauskopf JA, Backhouse ME, Jones D, Wold DE, Mammel MC, Mullet M, et al. A cost-effectiveness analysis of synthetic surfactant for rescue treatment of respiratory distress syndrome in premature infants weighing from 700 g to 1350 g. (pers. comm).
Mugford M, Piercy J, Chalmers I. Cost implications of different approaches to the prevention of respiratory distress syndrome. Arch Disease in Childhood 1991; *66*:757–764.
Phibbs CS, Phibbs RH, Wakeley Ann, Schlueter MA, Sniderman S, Tooley WH. Cost-effects of surfactant therapy for neonatal respiratory distress syndrome. J Pediatr 1993; *123*:953–962.
Shennan A, Dunn M, Possmayer F. Cost-effectiveness of single dose surfactant prophylaxis in infants of less than 30 weeks gestation. Pediatr Res 1989; *25*:231 a.
Simpson K, Lynch SR. Cost savings from the use of antenatal steroids to prevent respiratory distress syndrome and related conditions in premature infants. Am J Obstetrics Gynecol Forthcoming (1994).
Tubman TRJ, Halliday HL, Normand C. Cost of surfactant replacement treatment for severe neonatal respiratory distress syndrome: a randomised controlled trial. Br Med J 1990; *301*:842–845.
Virtanen M, Kuhlefelt S, Makela-Bengs P, Jarvenpaa A. p 90. Proceedings of the Annual Meeting of the European Society for Paediatric Research.

2. Exluded from review

Backhouse ME. Cost-effectiveness of Exosurf neonatal rescue therapy in infants with RDS. Adv in Paediatr 1992; Jan:8.
Hope P. Exogenous surfactants – They work and are expensive. Br Med J 1991; *303*:799–800.
Hyde CJ. Advising on the introduction of the drug exosurf in Norwich Health Authority [Dissertation], 1994.
Merritt TA, Hallman M, Vaucher Y, McFeeley E, Tubman TRJ. Impact of surfactant treatment on cost of neonatal intensive care: a cost-benefit analysis. J Perinatol 1990; *10*:416–419.
Phibbs CS, Phibbs RH, Tooley WH, Wakely A, Sniderman S. The cost effectiveness of synthetic surfactant therapy for neonatal respiratory distress syndrome. Clin Res 1990; *38*:178 a.
Robertson B. The dilemmas of surfactant replacement. J Perin Med 1991; *19*:183–188.
Sittlington N, Tubman R, Halliday HL. Surfactant replacement therapy for severe neonatal respiratory distress syndrome: implications for nursing care. Midwifery 1991; *7*:20–24.
Tubman TRJ, Halliday HL, Normand C. Economic impact of porcine surfactant replacement (Curosurf) for severe neonatal respiratory distress syndrome. J Perin Med 1991; *19*:403–407.

References

1 *Drummond MF, Stoddart GL, Torrance GW.* Methods for the economic evaluation of health care programmes. Oxford: Oxford University Press, 1987.

2 *Udvarhelyi S, Colditz GA, Rai A, Epstein AM.* Cost-benefit and cost-effectiveness analyses in the medical literature: are the methods being used correctly? Annals of Internal Medicine 1992; *116*:238–244.

3 *Light RJ, Pillemer DB.* Summing up: the science of reviewing research. Cambridge: Harvard University Press, 1984.

4 *Phibbs CS, Williams RL, Rhibbs RH.* Newborn risk factors and costs of neonatal intensive care. Pediatrics 1981; *68*:313–321.

5 *Doyle LW, Murton LJ, Kitchen WH.* Increasing the survival of extremely immature (24- to 28-weeks gestation) infants – at what cost? Medical Journal of Australia 1989; *150*: 558–568.

6 *Boyle MH, Torrance GW, Sinclair JC, Horwood SP.* Economic evaluation of neonatal intensive care of very-low-birthweight infants. New England Journal of Medicine 1983; *308*:1330–1337.

7 *Kitchen WH, Bowman E, Callanan C, et al.* The cost of improving the outcome for infants of birthweight 500–999 g in Victoria. Journal of Paediatric Child Health 1993; *29*:56–62.

8 *Walker DB, Vohr BR, Oh W.* Economic analysis of regionalized neonatal care for very low-birth-weight infants in the state of Rhode Island. Pediatrics 1985; *76*:69–74.

9 *Meberg A.* Cost-benefit analysis of neonatal care. Pediatric Research 1988; *24*:271.

Acknowledgements

This research is funded by the Department of Health (England). I would like to thank my colleagues Sarah Howard, Birgitta Rudbeck and Valerie Philcox for their help with literature searching.

Address for correspondence

Miranda Mugford
National Perinatal Epidemiology Unit
Radcliffe Infirmary
Oxford OX2 6HE/UK