

# ARCHIVES OF DISEASE IN CHILDHOOD

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## ORIGINAL ARTICLES

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### Cost implications of different approaches to the prevention of respiratory distress syndrome

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#### Abstract

**Because the incidence of both neonatal respiratory distress syndrome and neonatal mortality can be reduced by giving corticosteroids to women expected to deliver preterm and by giving surfactant to babies at high risk of developing hyaline membrane disease, we have considered what effects the adoption of one or both of these preventive policies would have on the costs of neonatal care. We have estimated the effects of treatment from overviews of the relevant controlled trials, and estimated costs from observations of care at one neonatal unit. Our results suggest that if either of these policies is adopted for all babies under 35 weeks' gestation at a drug cost of £150 or less/baby, the overall costs of care would be reduced by between 1 and 10%. The cost per survivor would be reduced by up to 16% even if the drug cost were to be as high as £550/baby. If the policies were to be adopted only for babies under 31 weeks' gestation, both policies would result in a reduction in cost of between 5 and 16%/survivor, although the increased survival resulting from the policies would lead to an increase in overall costs for babies of less than 31 weeks' gestation of between 7 and 32%.**

Although neonatal intensive care is more cost effective than many other widely accepted components of health care,<sup>1</sup> it is one of the most costly parts of the perinatal health services.<sup>2-13</sup> The costs of caring for babies who require artificial ventilation are particularly high,<sup>3 13</sup> and a high proportion of these babies have respiratory distress syndrome. Interventions that reduce the incidence of respiratory distress syndrome are clearly desirable because they reduce morbidity and mortality. In addition, however, they may reduce the costs of neonatal intensive care both for the health services and for those using them.

There is now strong evidence that the incidence of respiratory distress syndrome can be

reduced by at least two prophylactic policies: giving corticosteroids to women who are expected to deliver preterm, and giving surfactant to babies judged to be at high risk of developing respiratory distress syndrome. We are not the first to draw attention to the potential economic benefits of these forms of prophylaxis. The potential cost saving from using antenatal corticosteroids was noted in a leading article in the *Journal of Pediatrics* in 1984,<sup>14</sup> and it was estimated in one of the controlled trials of antenatal corticosteroids that prophylaxis had more than halved subsequent hospital charges in the group that had received the drugs.<sup>15</sup> The economic consequences of adopting early treatment with surfactant are less certain, because it is clear that the market cost of surfactant will be considerable. Although some of the available estimates suggest that savings are unlikely to be as dramatic as with antenatal corticosteroids,<sup>16</sup> giving surfactant early to immature infants may nevertheless be cost effective.<sup>17</sup>

In this paper we present estimates of the likely effects of introducing each of these prophylactic strategies on health service costs.

#### Materials and methods

Our aims were to derive estimates from overviews of controlled trials of the effects of the two policies on respiratory distress syndrome and mortality; to observe the costs of care for preterm babies in a unit where mothers did not (at the time of the study) routinely receive steroids as a prophylactic measure against respiratory distress syndrome, and where babies were not given surfactant; and, using these two sources of data, to predict the expected effect on costs of introducing different policies for prevention of respiratory distress syndrome in that unit.

#### ASSESSMENT OF EFFECTS OF INTERVENTIONS TO REDUCE THE INCIDENCE OF RESPIRATORY DISTRESS SYNDROME

##### *Prenatal administration of corticosteroids*

Estimates of the effects of corticosteroids on the

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incidence of respiratory distress syndrome and early neonatal death were derived from an analysis of 12 trials of prenatal corticosteroids incorporated in the overview reported by Crowley and her colleagues.<sup>18</sup> These trials together included a total of 3266 babies judged prenatally to have been at increased risk of developing respiratory distress syndrome. Although the entry criteria for these trials differed in some details, most of the babies studied were between 24 and 34 weeks' gestational age at birth.

#### *Early postnatal administration of surfactant*

Estimates of the effects of prophylactic surfactant were derived from overviews reported by Soll.<sup>19, 20</sup> The trials included babies of between 24 and 34 weeks' gestation (or who were in equivalent birthweight categories). The estimate of the effect of surfactant on the incidence of respiratory distress syndrome was based on data derived from the 1491 babies who participated in the 10 trials in which this outcome was reported. The estimate of the effect on the risk of death before discharge from hospital was based on data derived from 1924 babies who participated in a total of 14 trials.

The methods used in creating the overviews have been described more fully elsewhere.<sup>21</sup> Estimates of the effects of the two interventions were derived using a modification of the Mantel-Haenszel method,<sup>22</sup> and have been expressed as summary odds ratios with their 95% confidence intervals (CI).

#### ESTIMATION OF COSTS

Our costing study was carried out at the neonatal unit of the John Radcliffe Maternity Hospital, Oxford. The aim of this part of the study was to estimate the difference in costs of neonatal care for babies with and without respiratory distress syndrome who survived to be discharged, and also for those who died. These costs were estimated for babies admitted to the unit during the first half of 1989. The criteria for diagnosing respiratory distress syndrome were as follows: tachypnoea (more than 60 breaths/minute), substernal and intercostal recession; grunting, disease increasing in severity over 24–36 hours, and clinical diagnosis supported by radiological appearances.

To estimate the costs of treating respiratory distress syndrome, we estimated the cost at each of the levels of care from detailed review of the treatment of eight babies admitted during the period with a range of gestational ages. Four of these babies, with gestational ages of 28, 32, 34, and 36 weeks, met the diagnostic criteria for respiratory distress syndrome. We then selected the casenotes of four control babies, who were discharged from hospital at about the same time, but who had not developed respiratory distress syndrome and were as close in gestational age as we could find (30, 30, 32, and 36 weeks).

Procedures noted in the case records were costed by observation of care in the neonatal unit. One of us (JP) made detailed observations of the staffing, equipment, and clinical proce-

dures used in the care of newborns in the unit during the two months of July and August 1989. We obtained administrative data about the costs of services provided to the neonatal unit by the pharmacy, and by the departments of pathology, radiology, and physiotherapy. Overhead costs were for ward overheads, and did not include any element for capital value of the building. Details of the costing methods are given elsewhere.<sup>23</sup> From these data we used simple algebra to calculate average costs/day of care for three levels of care experienced by the eight babies in the detailed study: babies having intermittent positive pressure ventilation (IPPV), babies given oxygen without IPPV, and babies receiving other special care.

The expected cost of care for the 70 babies with gestational ages of less than 35 weeks admitted to the unit between 1 January and 30 June 1989 were calculated from data about the average length of stay at each of these levels of care, together with cost data from our observations about the costs of different levels of care. These costs were tabulated by diagnosis of respiratory distress syndrome, by whether the baby survived to be discharged or not, and by gestational age. To avoid the problem of measuring the use of resources in more than one hospital, we studied only babies born within the John Radcliffe Maternity Hospital and not transferred elsewhere.

The costs of steroids and surfactant were estimated after discussion with pharmacists and clinical staff. Giving steroids is likely to add relatively little to the cost of care, as a woman admitted to hospital with threatened preterm delivery is likely to receive a high level of obstetric and midwifery care whether or not she is given these drugs, thus the marginal cost is likely to be the cost of the drug and the materials needed to give it. The additional cost of giving surfactant to infants at high risk of developing respiratory distress syndrome is also likely to be low, because it is likely that continuous paediatric medical care would anyway be required at this stage in the life of these babies. The drug cost/dose is considerably higher than that for corticosteroids. For this study we calculated expected costs based on high and low estimates of its cost.

All estimates of financial costs have been based on 1989 prices. The estimated value of capital equipment used was calculated using the method now recommended for NHS accounts, using straight line depreciation over seven years, with an added annual fixed interest charge of 6%.

#### ESTIMATING THE LIKELY IMPACT OF INTRODUCING MEASURES TO PREVENT RESPIRATORY DISTRESS SYNDROME AT THE JOHN RADCLIFFE MATERNITY HOSPITAL

Data were collected from routine sources about all the babies of less than 35 weeks' gestation who were born between 1 January and 30 June 1989 and admitted to the neonatal unit. These provided information about whether babies had developed respiratory distress syndrome, and whether they had survived to be discharged. To

assess the proportion of babies that might have benefited from antenatal corticosteroids, further data about the length of time between the mothers' admission and their delivery were collected from the labour ward delivery book.

To assess the likely impact of adopting each of these prophylactic strategies on the incidence of respiratory distress syndrome and death in this cohort, we calculated expected numbers by applying the typical odds ratios derived from the trial overviews to the observed odds of occurrence of the two outcomes, using the formula:

$$R_e = \frac{NR_oT/(N-R_o)}{1 + [R_oT/(N-R_o)]}$$

Where:  $R_e$  = expected number with particular outcome with prophylactic intervention;  $N$  = total number of babies;  $R_o$  = observed number of babies with particular outcome without the prophylactic intervention; and  $T$  = typical odds ratio for the effect of the prophylactic intervention.

**Results**

**EFFECTIVENESS OF PROPHYLACTIC CORTICOSTEROIDS AND SURFACTANT**

Table 1 shows typical odds ratios and 95% CI for the effects of prenatal corticosteroids and early postnatal surfactant on respiratory distress syndrome and on mortality. The 95% CI for

*Table 1 Effect of prophylaxis with antenatal corticosteroids and early surfactant administration on respiratory distress syndrome and mortality*

	No of trials	No of babies	Typical odds ratio	95% CI
<b>Antenatal corticosteroids:<sup>18</sup></b>				
Respiratory distress syndrome	12	3266	0.49	0.41 to 0.60
Early neonatal death	12	3266	0.59	0.47 to 0.75
<b>Early postnatal surfactant administration:<sup>19, 20</sup></b>				
Respiratory distress syndrome	10	1491	0.61	0.49 to 0.75
Death before discharge	14	1924	0.55	0.43 to 0.70

the typical odds ratio (the ratio between the odds for the intervention and control populations) for antenatal corticosteroid administration is between 0.41 and 0.60, which means that the prophylaxis is likely to reduce the odds of respiratory distress syndrome by between about 60 and 40%. The reduction in the odds of respiratory distress syndrome likely to follow early administration of surfactant lies between about 50 and 25%, because the confidence interval for the typical odds ratio is between 0.49 and 0.75. Both prophylactic regimens are also associated with a significant and clinically important reduction in the risk of death. The available data on longer term effects are reassuring for corticosteroids but not yet available for surfactant.<sup>18</sup>

**COSTS OF RESPIRATORY DISTRESS SYNDROME**

The detailed costs of caring for babies with and without respiratory distress syndrome with comparable gestational ages are shown in table 2. The mean cost of caring for the four babies with respiratory distress syndrome (£6554/baby) was about twice that for the four controls with similar gestational ages who did not develop respiratory distress syndrome (£3265/baby). A breakdown of the costs shows that the largest absolute difference in costs is for nursing and equipment costs. Although they accounted for a smaller part of the total costs, however, relative differences in costs were greatest for biochemistry, radiology, oxygen, and pharmacy.

From these data we estimated the costs/day of care at each of the three prespecified levels of care to be as follows: with IPPV, £272; with oxygen but no IPPV, £118; and for other care in the unit, £102. Based on these costs, table 3 shows, for the 70 babies included in our study, the costs by gestational age group, survival to discharge, and diagnosis of respiratory distress syndrome. Whether or not they had respiratory distress syndrome, babies who died had received intensive care throughout their stay in the neonatal unit. Table 3 shows that the average cost of care for surviving babies under 31

*Table 2 Differences in detailed cost (£ sterling) of care for four babies with and four without respiratory distress syndrome matched for gestational age*

	Mean cost/case at 1989 prices		Ratio of costs of care for those with respiratory distress syndrome: those without
	Babies with respiratory distress syndrome	Babies without respiratory distress syndrome matched for gestational age	
<b>Staff:</b>			
Nursing	2736.53	1608.73	1.7:1
Medical	962.39	498.24	1.9:1
Physiotherapy	32.45	24.61	1.3:1
Depreciation and running costs of equipment, including ultrasound	1172.08	560.44	2.1:1
<b>Pathology:</b>			
Biochemistry	227.19	46.25	4.9:1
Haematology	117.00	57.00	2.1:1
Microbiology	96.00	37.12	2.6:1
Radiology (including staff and equipment)	388.80	43.20	9.0:1
Disposable supplies	276.28	158.95	1.7:1
Oxygen	88.50	2.25	39.3:1
Pharmacy (including blood products and total parenteral nutrition)	199.65	29.20	6.8:1
Overheads (including all ancillary and support services)	250.57	191.14	1.3:1
<b>Total cost/case</b>	<b>6554.00</b>	<b>3265.00</b>	<b>2.0:1</b>

Table 3 Numbers of babies\* and costs of care by gestation, development of respiratory distress syndrome, and outcome

	With respiratory distress syndrome			Without respiratory distress syndrome		
	Total	Died	Survived	Total	Died	Survived
<b>Estimated cost per baby (£, 1989 prices)</b>						
Gestational age (completed weeks):						
<31	6385	1844	10100	4796	0	4796
31-34	3872	0	3872	2408	2227	2418
Total <35 weeks	5667	1844	7478	2635	2227	2649
<b>No of babies</b>						
Gestational age (completed weeks):						
<31	20	9	11	4	0	4
31-34	8	0	8	38	2	36
Total <35 weeks	28	9	19	42	2	40

\*Babies less than 35 weeks' gestation admitted to the John Radcliffe Maternity Hospital neonatal unit between 1 January and 30 June 1989.

weeks' gestation with respiratory distress syndrome was more than twice that for those who did not develop respiratory distress syndrome. For babies of 31 to 34 weeks' gestation the cost is 60% higher for those with respiratory distress syndrome.

Costs of antenatal corticosteroids are between £5 and £11/woman treated. In our calculations we have assumed the cost is £7.50. The costs of most surfactant preparations are not yet known. The costs of a course of artificial lung expanding compound (ALEC) are between £700 and £800. Another artificial surfactant preparation, 'Exosurf', has recently been given a product licence for sale in the United States and is being

marketed at \$450/10 ml vial (Wellcome, personal communication). Our calculations in this paper have used the two extreme values of £100 and £1000/baby treated.

#### IMPLICATIONS OF ADOPTING DIFFERENT STRATEGIES TO PREVENT RESPIRATORY DISTRESS SYNDROME

Of the 70 babies with a gestational age of less than 35 weeks' admitted to the neonatal unit during the first six months of 1989, 28 (40%) had a diagnosis of respiratory distress syndrome. Eleven babies died before discharge from hospital. Tables 4 and 5 show, for babies

Table 4 Numbers with different outcomes and costs of prevention of respiratory distress syndrome: babies &lt;35 weeks' gestation

Policy	No of babies		Died	Cost of neonatal care (£)*	Cost of prevention (£)	Total cost/baby		Total cost/survivor	
	Survived					£	Percentage change compared with no policy	£	Percentage change compared with no policy
	With respiratory distress syndrome	Without respiratory distress syndrome							
(1) No antenatal corticosteroid or surfactant	19	40	11	269 085	0	3844	0	4561	0
(2) With antenatal corticosteroids	12.8	48.7	8.5	240 985	525	3450	-10	3927	-14
(3) With prophylactic surfactant:									
(A) At £100	16	48.5	5.5	258 646	7000	3795	-1	4119	-10
(B) At £1000	16	48.5	5.5	258 646	70 000	4695	+22	5095	+12
(4) Antenatal corticosteroids and surfactant for those delivered within 6 hours of mother's admission:									
(A) At £100	12.4	50.6	7	240 157	1870	3458	-10	3842	-16
(B) At £1000	12.4	50.6	7	240 157	16 594	3668	-5	4075	-10

\*Excludes cost of any preventive treatment (corticosteroid or surfactant).

Table 5 Numbers with different outcomes and costs of prevention of respiratory distress syndrome: babies &lt;31 weeks' gestation

Policy	No of babies		Died	Cost of neonatal care (£)*	Cost of prevention (£)	Total cost/baby		Total cost/survivor	
	Survived					£	Percentage change compared with no policy	£	Percentage change compared with no policy
	With respiratory distress syndrome	Without respiratory distress syndrome							
(1) No antenatal corticosteroid or surfactant	11	4	9	146 880	0	6120	0	9792	0
(2) With antenatal corticosteroids	11.4	6.2	6.4	156 841	180	6542	+7	8912	-9
(3) With prophylactic surfactant:									
(A) At £100	12.1	8.9	3	170 426	2400	7201	+18	8230	-16
(B) At £1000	12.1	8.9	3	170 426	24 000	8101	+32	9258	-5
(4) Antenatal corticosteroids and surfactant for those delivered within 6 hours of mother's admission:									
(A) At £100	11.7	6.7	5.6	160 630	880	6730	+10	8778	-10
(B) At £1000	11.7	6.7	5.6	160 630	7180	6992	-14	9120	-7

\*Excludes cost of any preventive treatment (corticosteroid or surfactant).

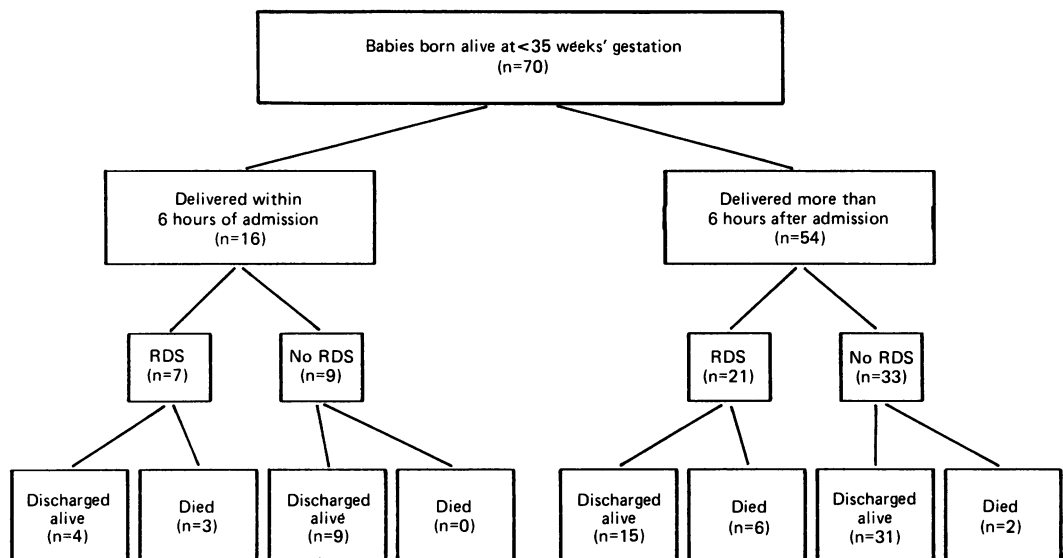


Figure 1 Observed number of babies <35 weeks' gestation with different outcomes. RDS, respiratory distress syndrome.

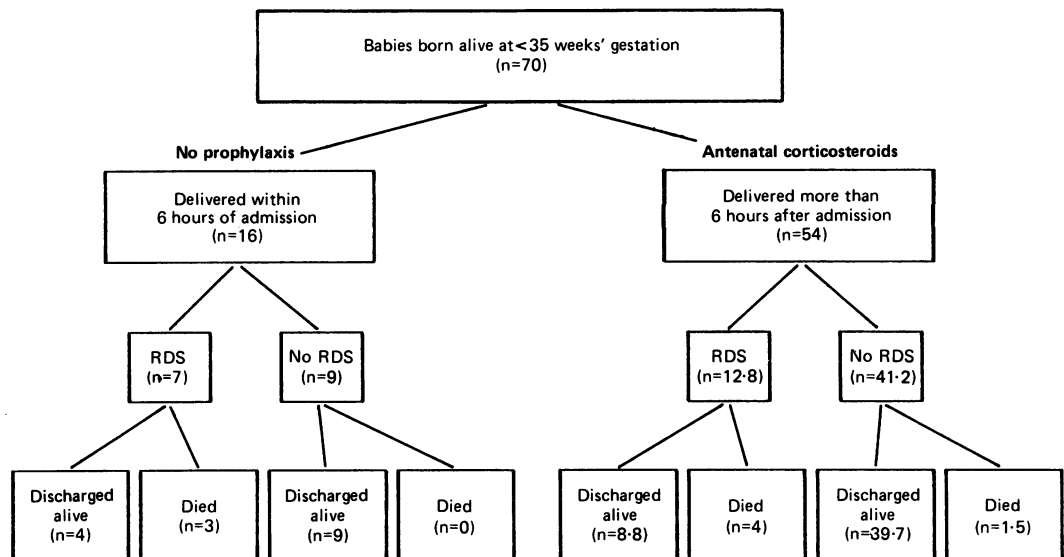


Figure 2 Estimated numbers of babies with different outcomes with a policy of giving antenatal corticosteroids. RDS, respiratory distress syndrome.

under 35 weeks' and under 31 weeks' gestation, respectively, the estimated costs for these 70 babies, firstly given the care that they experienced (care policy 1), and then for each of three policies for the prevention of respiratory distress syndrome (care policies 2, 3, and 4). For each policy including use of prophylactic surfactant, separate estimates are made for the upper and lower costs of surfactant.

Of the 70 babies, 16 were delivered within six hours of the mother's admission to hospital. Even if the mothers of these babies had been eligible to receive antenatal corticosteroids, we have assumed that the babies would not have benefited, but we have included the costs of giving corticosteroids to their mothers.

Figure 1 shows the observed numbers of babies with particular outcomes. Figures 2, 3, and 4 show the estimated numbers with different outcomes for three different policies of prevention of respiratory distress syndrome: firstly, use of antenatal corticosteroids for those

likely to benefit; secondly, use of early prophylactic surfactant for all babies; and thirdly, use of corticosteroids for those likely to benefit,

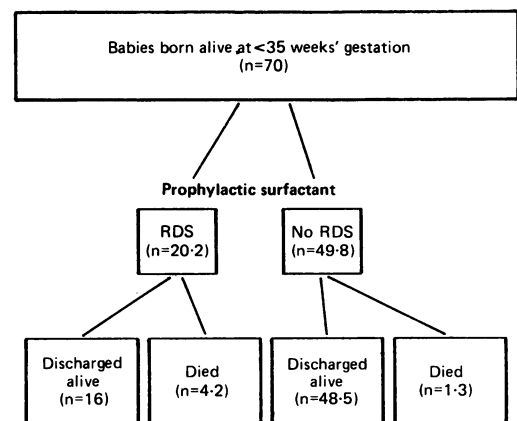


Figure 3 Estimated numbers of babies with different outcomes with a policy of early surfactant administration. RDS, respiratory distress syndrome.

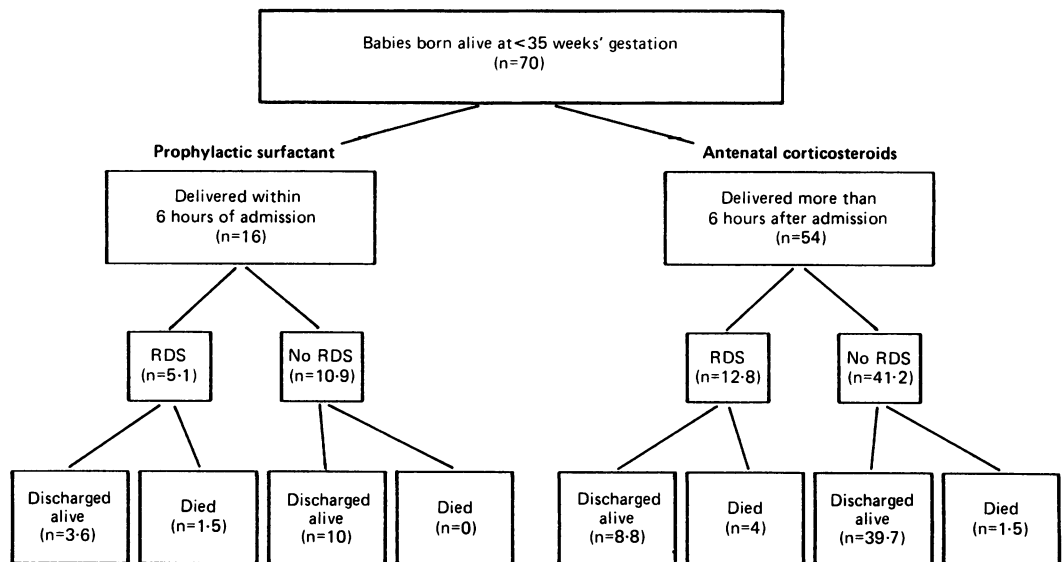


Figure 4 Estimated numbers of babies with different outcomes with a policy of giving antenatal corticosteroids combined with early surfactant administration for those babies delivered within six hours of mother's admission. RDS, respiratory distress syndrome.

together with early prophylactic surfactant for those who were unlikely to have benefited from corticosteroids. The expected costs arising from adopting each of these different policies for all babies under 35 weeks' gestation, and from adopting them only for babies under 31 weeks' gestation, are given in tables 4 and 5.

The cost of caring for the 70 babies of less than 35 weeks' gestation was estimated to have been £269 085. We estimate that the use of antenatal corticosteroids for women with gestations up to 35 weeks (policy 2 in table 4) would have reduced the number of cases of respiratory distress syndrome by 28%, and the number of deaths by 22%. Given these changes, we estimate that the costs of caring for the whole cohort of 70 babies would have been reduced from £269 085 to £240 985, which means a reduction in the average cost/baby by 10%; the cost/survivor would have been reduced from £4561 to £3927, a reduction of 14%. Applied only to mothers of babies with gestational ages of less than 31 weeks (table 5), prenatal administration of corticosteroids (policy 2 in table 5) would increase total costs by 7% because of the greater cost of caring for babies of this gestational age who would have survived, but this policy would have reduced the cost/survivor by 9%.

We estimate that early administration of surfactant to babies of less than 35 weeks' gestation (policies 3A and 3B in tables 4 and 5) would have reduced the number of cases of respiratory distress syndrome by 28%, and the number of deaths by half. The only difference between policies 3A and 3B is the cost of surfactant (costs of prevention in tables 4 and 5). The effectiveness is the same, and so the expected costs of neonatal care are the same. If the cost of surfactant were to be only £100/baby, the overall costs for the cohort of 70 babies would have decreased from £269 085 to £265 646, that is by 1%, and the cost/survivor would have been reduced from £4561 to £4119, a reduction of 10%. If the cost of surfactant were to be as

much as £1000/baby, the overall costs for the cohort of 70 babies would have increased from £269 085 to £328 646—that is by 22%—and the cost/survivor would have increased by 12%. If the policy were applied only to babies of less than 31 weeks' gestation (table 5), the total cost of care would have been increased by between 18 and 32%, depending on the cost of surfactant, but the cost/survivor would have been reduced by 5%, even at the higher cost of surfactant.

If antenatal corticosteroids had been used in all the women whose babies were likely to benefit and surfactant had been restricted to the remaining babies (policies 4A and 4B in tables 4 and 5) we estimate that, in the case of gestations of up to 35 weeks, the number of cases of respiratory distress syndrome and the number of deaths would both have been reduced by 36%. Once again, the two policies (4A and 4B) differ only in the costs of surfactant. At the lower end of the range of possible costs of surfactant (policy 4A in table 5), the costs of caring for the cohort of 70 babies would have been reduced from £269 085 to £242 027, that is by 10%. The cost/survivor would have been reduced by 16%. At the higher end of the range of possible costs of surfactant (policy 4B in table 5), the costs of caring for the cohort of 70 babies would still have been reduced by 5% and the cost/survivor by 10%. Applied only to babies of under 31 weeks' gestation (table 5), this policy would have increased total costs by between 10 and 14%, but the cost/survivor would have been reduced by at least 7%.

## Discussion

The data we have used to assess the effects of prophylactic corticosteroids and surfactant were derived from controlled trials involving substantial numbers of babies, so our estimates of the effects of these policies on respiratory distress syndrome and death are likely to be secure. Furthermore, the trials incorporated in the

overviews were conducted in a wide range of settings and so the results are likely to be widely applicable.

Although based on small numbers of babies studied in one neonatal intensive care nursery, our estimate that the cost of caring for babies with respiratory distress syndrome is double the cost of caring for babies of similar gestational age without respiratory distress syndrome is consistent with previous estimates. A study conducted in United States found that hospital charges for babies who had had respiratory distress syndrome were more than twice those for babies who had not developed respiratory distress syndrome, a difference which was largely accounted for by the increased need for assisted ventilation for those with respiratory distress syndrome.<sup>3</sup> These findings are consistent with those of a recent Irish study,<sup>14</sup> and are reflected in differences in reimbursement used by Medicare in the United States for babies with and without respiratory complications of prematurity.<sup>24</sup> The costs/day that we have calculated for different levels of care are low in comparison to costs estimated by Ryan *et al* in Leeds.<sup>10</sup> Several factors may explain this: we excluded outborn babies, who had higher costs in the Leeds study; secondly, the Leeds study included babies having operations and our study did not; and, thirdly, the overhead costs included in our study were much lower than those in the Leeds study. Our estimated average treatment costs are comparable with more recent data from a study of very preterm babies entered into a trial of surfactant treatment in Belfast, where the average cost/case was £5888.<sup>25</sup> Although the absolute costs of caring for babies with respiratory distress syndrome may vary substantially among health care settings, the ratio of costs within centres for babies of comparable gestations with and without respiratory distress syndrome (about 2:1) seems not to differ widely.

The organisation of care at the neonatal unit that we studied, where babies are moved to a different part of the unit when they are weaned from the ventilator and do not need intensive care, made it relatively straightforward for us to estimate the additional costs for babies receiving ventilation. This method could not be applied in those units where all care, at whatever level, is given to the baby in the same place. To estimate costs in such circumstances would require either more intensive work study or the use of some algorithm for allocation of costs between levels of care.

We estimated that there would have been a 10% reduction in the costs of caring for babies born at less than 35 weeks' gestation if antenatal corticosteroids had been used to prevent respiratory distress syndrome. Data from the randomised trials in which resource consequences were estimated suggest that our estimate may be conservative.<sup>15 26</sup> In our calculations we assumed that corticosteroids would have affected only the incidence of respiratory distress syndrome, yet the available evidence suggests that the incidence of both necrotising enterocolitis and periventricular haemorrhage would also have been reduced.<sup>19</sup> We also assumed that the

cost of treating respiratory distress syndrome was the same whether or not those babies who had respiratory distress syndrome had been given any of the possible preventive interventions. This also seems to be a conservative assumption in the light of evidence from those trials that have recorded data on severity of disease and need for ventilation.

About 3% of live births are at gestations of less than 35 weeks (S Cole, personal communication). If the costs of care and incidence of respiratory distress syndrome at this hospital are typical, the costs of care for babies of under 35 weeks' gestation born in England and Wales in 1989 would have been around £80m. If, as seems likely, antenatal corticosteroids are not widely used by British obstetricians for the prevention of respiratory distress syndrome, the potential reduction in neonatal costs could be as much as £8m in a year in England and Wales, which is more than 1% of the total amount estimated to have been spent on the maternity services.<sup>27</sup>

We estimate that routine early administration of surfactant to babies born before 35 weeks' gestation would result in a 4% reduction in the costs of subsequent care. A detailed analysis of hospital charges based on two consecutive trials of the prophylactic use of calf lung surfactant showed that the total cost of neonatal care, excluding the cost of surfactant, was similar for babies receiving surfactant and for those who did not.<sup>16</sup> The overall cost of such a policy will depend on the unit cost of surfactant. Our estimates indicate that the policy would result in overall net savings if the cost/baby of surfactant is £150 or less. Above this price there would not be overall savings, although the cost/survivor would still be reduced up to a surfactant cost/baby of £550. Our estimates suggest that restricting early administration of surfactant to babies born at less than 31 weeks' gestation would increase overall costs while reducing the cost/survivor. Analyses of data collected within a controlled trial conducted in Canada have shown that the cost of caring for babies who received surfactant were 27% lower than the cost of caring for control babies.<sup>17</sup> The difference in average cost/patient was estimated to have been \$C10 000, which would certainly outweigh the likely costs of surfactant.

Although our analyses have not assumed that there would be an additional benefit to babies of receiving both corticosteroids and surfactant, there is some evidence to suggest that this additive effect may exist.<sup>28 29</sup> This too, therefore, may have led us to underestimate the cost effectiveness of these policies.

Our estimates of the changes in costs arising from policies to reduce the incidence of respiratory distress syndrome were based on relatively small numbers of cases observed in a particular unit. Others may wish to apply the approach we adopted to data derived from their own units. Furthermore, it may turn out to be preferable on cost and other grounds to withhold surfactant until clear evidence has emerged that the baby concerned has begun to develop the signs of respiratory distress syndrome. A report of a recent analysis of babies who had already

developed severe respiratory distress syndrome and had been entered into a randomised trial of surfactant treatment concluded that surfactant reduced the cost/survivor. Taking account of subsequent neonatal morbidity, the use of surfactant treatment was found to reduce the cost of achieving a quality adjusted life year by £710.<sup>25</sup> The relative merits of early surfactant prophylaxis compared with surfactant treatment of babies who have already developed respiratory distress syndrome is currently being assessed in a number of controlled trials.<sup>30</sup> In at least two trials the relative costs of the alternative approaches will be assessed.<sup>31 32</sup>

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