Trial of labour versus elective repeat caesarean section: A cost-effectiveness analysis

ALLISON SHORTEN, DONALD E LEWIS AND BRETT SHORTEN

Allison Shorten is a Lecturer in Midwifery, Department of Nursing, University of Wollongong. Donald E Lewis is a Professor in the Department of Economics, University of Wollongong. Brett Shorten is a Research Fellow at the Centre for Hospital Management and Information Systems Research, University of New South Wales.

Abstract

For subsequent births, women who have experienced previous caesarean section face a choice between elective caesarean section and trial of labour. The study reported in this paper utilises Australian hospital data to compare birth outcomes and health system costs of these two options. Although trial of labour is more expensive if the result is an emergency caesarean section, high rates of successful vaginal delivery mean that, overall, trial of labour is found to be 30 per cent less expensive than elective caesarean section. It is estimated that trial of labour remains the most cost-effective option as long as less than 68 per cent of women require emergency caesarean section. This study highlights the potential importance of more accurate information about a broader range of costs and outcomes in order for stronger conclusions to be drawn.

Introduction

High health care costs associated with high rates of caesarean section (CS) are of concern to health economists, health system administrators and society in general. Once a woman's first CS occurs, however, difficult decisions are faced

by clinicians and clients as to the optimal management of future pregnancies and labour. This issue has led to clinical debate about the use of repeat elective CS versus trial of labour (TOL) for women who have experienced previous CS. TOL is defined as a monitored management of labour with the aim of vaginal delivery. The result will either be successful vaginal birth or emergency CS. This paper presents Australian evidence on relative health care system costs of elective CS versus TOL. This information is critical in determining the most cost-effective option for the management of this clinical problem, taking maternal and neonatal health outcomes into account.

It is well documented that CS rates have increased dramatically over the last several decades. In the United States, for example, the rate of CS increased from 4.5 per cent in 1965 to 17.9 per cent in 1981 (Lomas & Enkin 1989, p 1185) and further increased to 24 per cent by 1986 (Notzon, Placek & Taffel 1987), before stabilising at around this level (Hanley et al. 1996). In Australia, a fourfold increase in CS rates occurred between the 1960s and the early 1980s, with further increases since that time (Lancaster & Pedisich 1993, p 6). Research on the benefits of these increases has yielded mixed results, but the overall conclusion is that these very large increases in CS rates have not led to significant declines in perinatal mortality (Lomas & Enkin 1989, p 1184).

Large variations in CS rates have been observed between countries (Lomas & Enkin 1989, p 1184), between regions within countries (Lancaster & Pedisich 1993, p 7) and also between individual hospitals within a region (New South Wales Health Department 1996, p 26). In Australia in 1990, for example, CS rates varied from a low of 14.7 per cent in Tasmania to a high of 21.4 per cent in South Australia (Lancaster & Pedisich 1993, p 7). As regards variations in CS between individual hospitals, Victorian data for 1988 suggest large variations across apparently similar hospital categories. Hospitals with relatively uncomplicated patient populations showed much greater variation (14.2 per cent to 25.3 per cent) than large teaching hospitals (16.9 per cent to 17.3 per cent) (Health Department of Victoria 1990). Although a large number of possible clinical reasons for these variations have been advanced (Jonas, Chan & MacHarper 1989; Hanley et al. 1996), these factors cannot explain all of the large variations observed. This has led to the conclusion that:

> *observed differences in operative delivery rates suggest that collectively the obstetric community is uncertain as to when caesarean section is indicated, and represent substantive differences in clinical policy adopted by the obstetric communities of the various areas studied* (Lomas & Enkin 1989, p 1189).

In any analysis which seeks to address what might be the appropriate rate of CS, one important issue is that of repeat CS rates of women who have had one or more previous CS. This is particularly the case given that repeat CS rates have often been as high as 97 per cent (Lomas & Enkin 1989, p 1187), due to practice policy of 'once a caesarean always a caesarean' (Paul & Miller 1995, p 1903). It has been suggested that repeat CS contributes significantly to overall CS rates, with 35 per cent of all CS in the United States occurring as a direct result of previous CS (Paul & Miller 1995, p 1905; Hanley et al. 1996, p 883). Furthermore, Hanley et al. (p 883) report that 48 per cent of the increase in CS rates in the United States from 1980 to 1985 was associated with delivery of women who had experienced previous caesarean delivery. Although less evidence is available on the extent of repeat CS in Australia, one estimate is that it accounted for 29.9 per cent of all CS births in 1987 (Stephenson 1992, cited in Wagner 1994, p 181).

Clinical evidence about trial of labour

As with total CS rates, high rates of repeat CS are not necessarily consistent with evidence from clinical research. One alternative to elective CS that is often advocated is TOL. A range of studies provide evidence that TOL is safe for women who have no other medical indication to require repeat CS (Lilford et al. 1990; Walton, Ludlow & Willis 1993; Maher, Cave & Haran 1994). Evidence suggests that at least 60 per cent and quite possibly close to 85 per cent of women who have experienced previous CS should be regarded as eligible for TOL (Norman, Kostovcik & Lanning 1993; Hanley et al. 1996), and that 55 to 85 per cent of these women would be expected to achieve successful vaginal birth (Catanese 1987, pp 37–8). Despite this body of research, and despite research-based guidelines such as those from the Canadian National Consensus Conference on Aspects of Caesarean Birth (1986 cited in Norman, Kostovcik & Lanning 1993, p 432), which recommended that 'with a few specific exceptions, a trial of labour be provided for women who had previously undergone a low transverse caesarean section', rates of repeat elective CS remain high.

International and Australian sources reveal satisfactory outcomes in terms of maternal and neonatal morbidity and mortality for both elective repeat CS and TOL. Whilst maternal fever and infection have been found to be higher in the elective CS groups than in the TOL groups (Enkin 1989, p 1201), emergency CS groups have been reported to experience higher rates of operative complications than elective CS groups (McMahon et al. 1996). Some Australian studies reveal lower rates of maternal and infant morbidity for vaginal delivery

than all CS, with fewer complications noted and shorter average length of stay (Lovell 1996, p 8). Others report little difference in perinatal outcomes when policies to promote TOL succeed in reducing the number of elective CS (Maher, Cave & Haran 1994).

Although there have been numerous studies which analyse and compare the cost of CS versus vaginal delivery (Clark, Mugford & Paterson 1991; Keeler & Brodie 1993; King 1993; Brown 1996; Gruber & Owings 1996; Rouse et al. 1996), little analysis, either overseas or in Australia, explicitly analyses the relative costs of repeat CS versus TOL.

Methodology

This paper represents a cost-effectiveness analysis of repeat CS versus TOL, taking a health care system viewpoint and allowing for different outcomes of TOL and elective CS. The comparison allows for different rates of both maternal and infant complications, and incorporates information on the costs to the Australian health care system of these complications. However, a range of potential costs and benefits of the two alternatives, such as financial and psychological factors affecting mothers, their families and other interested parties, are not considered. Hence the analysis stops short of a full cost-utility approach, as necessary data are not available.

Data

Data were collected from retrospective medical records of all 198 women who underwent delivery at the Illawarra Regional Hospital, Wollongong, between 1 July 1995 and 12 March 1997, who had experienced previous CS and whose medical record data were complete. Twenty-eight of these women, who were not eligible for TOL due to medical indications, were excluded from the study so that the delivery outcomes for a defined group of women eligible for TOL could be analysed (see Appendix 1 for exclusion criteria). This implies an eligibility rate of 85.9 per cent, which is comparable with upper limits of other studies, which suggest eligibility rates between 60 and 84 per cent (Norman, Kostovcik & Lanning 1993; Hanley et al. 1996).

The cost-effectiveness approach adopted uses Australian National Diagnosis Related Group (AN-DRG) data to facilitate a comparison of outcomes in terms of morbidity, mortality and average length of stay for women in the study. The AN-DRG classifications were retrieved from the individual medical record data of 170 eligible women, which had already been coded by a DRG coder in the

Medical Record Department of Illawarra Regional Hospital. Appendix 2 provides the relevant obstetric and neonatal categories into which women and neonates were coded. Neonatal care is usually incorporated into the cost of care of each delivery mode unless the neonate is admitted to a special care/intensive care neonatal nursery (SCNN), where it is coded according to diagnosis. The AN-DRG costs from version 3 (Commonwealth Department of Health and Family Services 1996) were then applied to the DRG classification for each patient.

It should be noted that our analysis assumes that, for women undergoing CS, the average severity, and hence cost, within each relevant DRG is the same for those requiring emergency CS as for the elective CS group. Similarly, it is assumed that, for TOL women achieving vaginal birth, the average cost within each DRG is the same as for all women experiencing vaginal birth. To the extent that these assumptions are not fulfilled, and if the TOL group is more expensive within DRGs, the results of this study may be biased in favour of the TOL option. However, the issue of within-DRG casemix severity is beyond the scope of this paper.

Results

Figure 1 provides a summary of mode of delivery for the 170 women eligible for TOL who delivered at the Illawarra Regional Hospital during the study period. A total of 108 (63.5 per cent) eligible women elected TOL, whilst 62 (36.5 per cent) elected repeat CS. The successful vaginal birth rate for TOL was 79.6 per cent (86 women). The remaining 20.4 per cent (22 women) underwent emergency CS at some time during their labour.

Table 1 provides the distribution of AN-DRGs for each of the delivery outcomes depicted in Figure 1, and the average cost per delivery mode, calculated according to AN-DRGs allocated to each group. It provides data on the cost of TOL versus elective CS, and also indicates the number of complications which occurred during the delivery or during the post-delivery hospital stay.

The total average cost of TOL (vaginal delivery) is $2524 and the total average cost of TOL (emergency CS) is $5319. The overall total average cost of TOL is $3093, versus $4424 for elective CS. Total average cost of TOL is calculated as 86/108 (79.6 per cent) of $2524 plus 22/108 (20.4 per cent) of $5319. Thus the average cost of TOL is 30.1 per cent lower than the average cost of elective CS.

Table 1 suggests that those who have a TOL but require an emergency CS incur higher costs than those with elective CS, primarily due to babies being admitted

Table 1: Maternal and neonatal AN-DRG costs and outcomes by mode of delivery

Mode of delivery	Mother DRG	Number	Average cost mother ($)	Baby DRG	Number	Average cost baby ($)	Total average cost ($)
TOL Vaginal delivery	674	63	1883	701	6	1095	
	675	4	2357	719	3	4885	
	676	14	2673	720	0	3186	
	688	5	3553	725	1	3195	
				726	1	2266	
				727	9	789	
Total		*86*	*2131*		*20*	*393*	*2524*
TOL Emergency CS	670	12	3791	701	4	1095	
	671	3	4367	719	0	4885	
	672	6	5215	720	0	3186	
	687	1	7033	725	1	3195	
				726	1	2266	
				727	13	789	
Total		*22*	*4405*		*19*	*914*	*5319*
Total TOL		**108**	**2594**		**39**	**499**	**3093**
Elective CS	670	49	3791	701	4	1095	
	671	4	4367	719	0	4885	
	672	7	5215	720	1	3186	
	687	2	7033	725	0	3195	
				726	5	2266	
				727	2	789	
Total elective CS		**62**	**4094**		**12**	**330**	**4424**

Note: The average cost incurred by neonates for each of the three delivery modes is calculated by dividing the total cost by the total number of babies born under each delivery mode, not the smaller number admitted to SCNN.

to a SCNN. This group incurs an average SCNN cost of $914, compared with $393 for the TOL (vaginal delivery) group and $330 for the elective CS group. However, much of this additional expenditure seems to be due to babies admitted to SCNN under DRG 727, which concerns babies without complications being admitted for largely observational reasons. This suggests that such babies are routinely admitted to SCNN and the question of whether these babies are any 'sicker' than babies born under either of the other two delivery options arises. To explore this issue, we classified babies by birth mode and by whether they were admitted to SCNN under DRG 727, admitted under more serious DRGs or not admitted to SCNN at all.

Comparisons by mode of delivery were made of birthweight, and one minute and five minute Apgar scores. The Apgar is a score out of a possible 10 which indicates neonatal condition at birth and need for resuscitation at time of birth. Scores range from zero (worst condition) to ten (best condition). The results are presented in Table 2. As expected, average birthweight was found to be lower for the elective CS mode, as the length of the pregnancy is often shortened by the advance scheduling of the CS procedure. Hence Apgar scores probably provide a clearer picture of the relative condition at birth of babies born under the different delivery modes.

If it is true that babies born under the TOL (emergency CS) mode are routinely admitted to SCNN irrespective of their condition at birth, we would expect to observe two specific sets of results in Table 2. Firstly, we would expect to find that, among all babies admitted under DRG 727, those born via the TOL (emergency CS) mode would have higher average Apgar scores than those born under alternative delivery modes. Although the evaluation of this hypothesis is hampered by the relatively small number of babies admitted to SCNN under DRG 727 (a total of 24), results are nevertheless consistent with the hypothesis. The average Apgar scores (one minute and five minute respectively) of 8.77 and 9.31 for the TOL (emergency CS) babies were higher than for either of the other delivery modes.

Secondly, if routine admission of TOL (emergency CS) babies is the norm, we would expect to find that, on average, their condition at birth would be similar to babies born under other delivery modes but not admitted to SCNN at all. Again, the hypothesis is confirmed. Indeed, babies born under TOL (emergency CS) and admitted to SCNN under DRG 727 had higher average Apgar scores than babies born under either alternative delivery mode and not admitted to

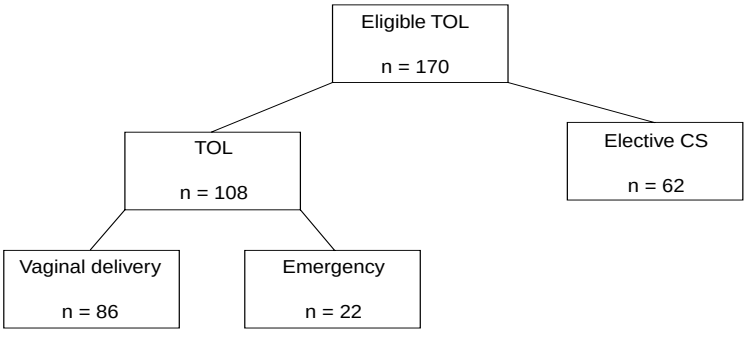

Figure 1: Mode of delivery for eligible TOL group

Table 2: Average birthweight and Apgar scores by mode of delivery and SCNN classification

Delivery mode	SCNN classification	Number	Birthweight (grams)	Apgar score (1 minute)	Apgar score (5 minutes)
TOL Vaginal delivery	Admitted DRG 727	9	4018	7.78	8.78
	Admitted Other DRG	11	2879	6.64	7.82
	Not Admitted	65	3518	8.38	9.26
Total		*85*	*3488*	*8.09*	*9.02*
TOL Emergency CS	Admitted DRG 727	13	3694	8.77	9.31
	Admitted Other DRG	6	3623	7.50	8.83
	Not Admitted	3	3300	9.00	10.00
Total		*22*	*3621*	*8.45*	*9.27*
Total TOL		**107**	**3515**	**8.16**	**9.07**
Elective CS	Admitted DRG 727	2	3255	5.00	8.50
	Admitted Other DRG	10	3347	6.70	8.70
	Not Admitted	50	3405	8.60	9.30
Total elective CS		**62**	**3391**	**8.18**	**9.18**

Note: In the TOL (vaginal delivery) mode, one baby is omitted due to incomplete data.

SCNN. However, as expected, the difference in these average scores was less than for the previous comparison.

Although this analysis is less than definitive owing to small sample size in some categories of interest, certainly the results from Table 2 are not consistent with the hypothesis that among either TOL (vaginal birth) or TOL (emergency CS) babies born without serious complications, those born under TOL (emergency CS) require more careful monitoring. Thus these results suggest that routine admission of babies born under TOL (emergency CS) to SCNN may not be a cost-effective policy and this issue may deserve further attention. That is, if routine admission to SCNN in this situation was not practised, the cost advantage of TOL over elective CS would be even higher than the 30 per cent reported above. This will be addressed below in the sensitivity analysis.

It should be noted, however, that the TOL (emergency CS) group had a higher 'serious' admission rate to SCNN than did the other groups. Admission rates for these more serious DRGs were 27.3 per cent for TOL (emergency CS) versus 12.9 per cent and 16.1 per cent respectively for the TOL (vaginal birth) and elective CS groups. Hence at least part of the reason for the much higher SCNN cost of the TOL (emergency CS) group is due to these higher admission rates.

Discussion

Analysis suggests that TOL is the most cost-effective option for women who have experienced previous CS. The cost advantage for the TOL option over the elective repeat CS is estimated as $1331 per case, or 30.1 per cent. This suggests that policies designed to encourage expectant mothers who have had a previous CS to proceed to TOL have the potential for reducing health care expenditure.

A potential methodological problem with the study is the possibility of selection bias. We are interested in the relative cost of elective repeat CS and TOL amongst eligible women. Women who are obviously not able to proceed to TOL are screened from our study. Nevertheless, among those women deemed to be eligible, there may be real but unobservable differences between those who elect (with or without their doctor's recommendation) CS and those who elect to proceed to TOL. It is possible that the likelihood of complications is greater amongst those who choose to have elective CS. Under such conditions it would not be surprising to find that the average cost of elective CS is greater than the average cost of TOL.

Although there is no way of measuring the extent, if any, of this problem (a clinical trial in which eligible women were randomly allocated to TOL and elective CS would probably be considered to be unethical and inappropriate), it is interesting to compare the distribution of CS (by the four DRG categories) amongst those who elect CS and those who elect TOL but end up having an emergency CS. The results are shown in Table 3. Although the number of cases is relatively small, there is no significant difference in the two distributions. (Chi-squared is 5.12 which is less than the theoretical chi-squared at the 0.10 level of significance and three degrees of freedom (6.25).) This suggests that the distribution of CS outcomes is approximately the same for both groups, that is, those electing CS do not have a higher probability of suffering complications.

Table 3: Distribution of CS by DRG for elective repeat CS and emergency CS

AN-DRG	Emergency CS after TOL Number (%)	Elective repeat CS Number (%)
670	12 (54.5)	49 (79.0)
671	3 (13.6)	4 (6.5)
672	6 (27.3)	7 (11.3)
687	1 (4.5)	2 (3.2)
Total	**22 (100.0)**	**62 (100.0)**

Even if some women who elect CS have an unobservable characteristic which makes them more at risk or inherently more expensive, there may be many women who elect CS who could have proceeded with TOL. If so, large resource savings are possible if more women (and their doctors) can be encouraged to proceed with TOL as the average cost of TOL is less than the average cost of elective CS ($3093 versus $4424). On the other hand, if many women are incorrectly advised to proceed to TOL and a disproportionately large number of these require emergency CS, then total resource use may actually be increased. This could occur as the cost of emergency CS is greater than elective CS ($5319 versus $4424).

Based on the costs that have been measured in this study and the observed distributions, we can determine the conditions under which resources can be saved by encouraging more women to proceed to TOL. If those who are persuaded to proceed to TOL have the same distribution of outcomes as those previously observed, the cost saving will be $1331 per case. At the other extreme, if all those persuaded to proceed to TOL end up requiring emergency CS, then the additional cost will be $895 per case. The break-even point will occur when 68 per cent of those persuaded require emergency CS. That is, if upon proceeding to TOL there is a probability of emergency CS greater than 68 per cent, it will be cheaper to have an elective CS. (To determine the break-even point, let p equal the probability of TOL resulting in emergency CS and (1–p) equal the probability of TOL resulting in vaginal delivery. The average cost of TOL will equal the average cost of elective CS when $4424 = $5319 (p) + $2524 (1–p). Solving, p = 0.680 or 68 per cent). In our judgment, it is unlikely that amongst those currently choosing elective CS, 68 per cent or more in the entire population will require emergency CS. This would be much higher than the 20.4 per cent observed in our sample. In short, persuading more women to proceed to TOL is likely to save resources.

Strictly speaking, the cost savings from the greater use of TOL will be determined by the difference in the marginal costs of TOL and elective CS and not the difference in average costs as calculated above. Data on marginal costs are not available, but the distinction between marginal costs and average costs is not likely to be important for several reasons. Firstly, if hospitals are functioning at or near full capacity, marginal cost will equal average cost for each DRG. Secondly, if the number of cases which are shifted from TOL to elective CS is large, marginal and average costs will be similar. Finally, even if marginal cost does not equal average cost for each DRG, differences in average costs between TOL and elective CS may closely approximate differences in marginal costs between the two categories.

Sensitivity analysis

The following sensitivity analysis identifies elements which may influence the robustness of these results. The two major areas identified in the sensitivity analysis include the 'routine' admission of babies born under emergency CS after TOL to SCNN for observation, and the consideration of sample characteristics and size. The issue of probability of successful vaginal birth versus emergency CS will also be addressed.

Routine admission to SCNN

As discussed above, results suggest that babies born under emergency CS after TOL are often routinely admitted to SCNN under DRG 727. Only three of 22 such babies (13.6 per cent) were not admitted to SCNN at all, and 13 (or 59.1 per cent) were admitted under DRG 727. In contrast, only 10.5 per cent of TOL (vaginal delivery) babies and 3.2 per cent of elective CS babies were admitted under this DRG. Analysis of birthweight and Apgar scores suggests that the TOL (emergency CS) babies in this group may have been no 'sicker' than the others.

To test the sensitivity of costs to this practice policy, we simulated the same percentage (10.5 per cent) for TOL (emergency CS) babies being admitted to SCNN under DRG 727 as the TOL (vaginal delivery) mode. The average SCNN cost for the former group fell from $914 to $530, leading to a new total average cost of $4935 for this group (down from $5319). The average cost of the TOL option thus fell by $78 from $3093 to $3015, increasing the cost advantage of TOL from 30.1 per cent to 31.8 per cent. Thus small additional resource savings may be possible with a policy of not routinely admitting babies born under TOL (emergency CS) mode to SCNN.

Simulated costs for other published outcome-based studies

It is possible to utilise data from two other recent studies, those of Lovell (1996) and McMahon et al. (1996), and apply AN-DRG costs used in this study to their outcome data. This assists in observing the degree to which our sample and results can be generalised to other samples. Refer to Appendix 3 for a discussion of assumptions made in this analysis.

Lovell (1996) provides a retrospective review of 333 pregnancies in Australian women who had experienced previous CS. The study, based in Liverpool Hospital, Sydney, provides data on outcomes for mothers and babies who either underwent TOL or elective CS between January 1989 and July 1994. AN-DRG data utilised for the present study were applied to the outcomes identified in

Table 4: Maternal and neonatal AN-DRG costs applied to Lovell's (1996) published outcomes by mode of delivery

Mode of delivery	Mother DRG	Number	Average cost Mother ($)	Baby DRG	Number	Average cost Baby ($)	Total average cost ($)
TOL Vaginal delivery	674	146	1883	701	0	1095	
	675	32	2357	719	7	4885	
	676	13	2673	720	0	3186	
	688	6	3553	725	8	3195	
				726	8	2266	
				727	8	789	
Total		*197*	*2063*		*31*	*427*	*2490*
TOL Emergency CS	670	35	3791	701	0	1095	
	671	0	4367	719	1	4885	
	672	2	5215	720	0	3186	
	687	10	7033	725	3	3195	
				726	1	2266	
				727	5	789	
Total		*47*	*4541*		*10*	*440*	*4981*
Total TOL		**244**	**2540**		**41**	**430**	**2970**
Elective CS	670	76	3791	701	0	1095	
	671	0	4367	719	3	4885	
	672	13	5215	720	0	3186	
	687	0	7033	725	11	3195	
				726	5	2266	
				727	3	789	
Total elective CS		**89**	**3999**		**22**	**713**	**4712**

Note: The average cost incurred by neonates for each of the three delivery modes is calculated by dividing the total cost by the total number of babies born under each delivery mode, not the smaller number admitted to SCNN.

Lovell's study. Table 4 provides data on cost and outcomes by mode of delivery. The average cost for TOL was $2970, calculated as 197/244 (80.7 per cent) of $2490 plus 47/244 (19.3 per cent) of $4981 and is 37.0 per cent less expensive per case than the elective CS cost of $4712. The larger cost advantage of TOL using Lovell's data may be partly due to Lovell's failure to exclude elective CS clients who were medically inappropriate for TOL, who presumably have higher rates of complication. It is not due to a higher vaginal birth rate for TOL, as Lovell's vaginal birth rate of 80.7 per cent is almost the same as the 79.6 per cent found in the present study.

Overall, Lovell's data, also for a New South Wales hospital over a recent period, provide a similar picture to the present study of the potential cost savings of TOL compared to elective CS. In particular, the average 'mother' costs for each delivery mode are remarkably similar in both studies. However, average SCNN costs vary considerably between the two samples studied.

The study by McMahon et al. (1996) relates to data from Novia Scotia, Canada, for the period 1986–1992. It is noteworthy in that it provides a much larger sample size (6138 women) than other studies in this field. It is also characterised by a much lower overall vaginal birth rate (60.4 per cent) of TOL, yielding an estimate near the lower bound of the range of estimates from other studies. Unfortunately, only outcomes for mothers were specified. Neonatal admission to SCNN and infant Apgar scores were stated to be similar for each mode of delivery (McMahon et al. 1996, p 690). Therefore, figures from the current study were used to approximate SCNN cost (see Table 1). This may, in fact, overestimate the cost of TOL due to higher rates of admission to SCNN for a range of reasons already discussed. Table 5 provides cost information applied to the outcome data from the study by McMahon and colleagues.

Taking the admission to SCNN into account, the estimated average cost for TOL was $3407. This figure is calculated as 1962/3249 (60.4 per cent) of $2391, plus 1287/3249 (39.6 per cent) of $4957 and is $877 or 20.5 per cent less expensive per case than the average elective CS cost of $4284. If babies are excluded from the simulation, as McMahon et al. do not provide necessary data on admission to SCNN, TOL is 29.0 per cent less expensive than elective CS ($2808 versus $3954).

It should be acknowledged that due to the rarity of some complications such as uterine rupture such complications may not appear in any given sample being studied. Given that this event did occur in two cases in the Lovell study and eleven cases in the McMahon et al. study, one can see that these rare events did not affect the results to any significant degree, as we are interested in comparing mean medical and cost outcomes which are only marginally affected by extreme events.

The findings of McMahon et al. of a 60 per cent vaginal delivery rate for TOL, consistent with the lower bound of the range of estimates from other studies, suggest that it may be useful to simulate a 60 per cent vaginal delivery rate for the current study. This is also in the spirit of the break-even point for successful TOL, below which elective CS becomes a more cost-effective option, as discussed earlier. From Table 1, under the assumption of a 60 per cent vaginal birth rate for TOL, elective CS average cost remains unchanged at $4424. Average cost of TOL becomes $3642 ((0.6 X $2524) + (0.4 X $5319)). TOL is still the most

Table 5: Maternal and neonatal AN-DRG costs applied to McMahon et al's (1996) published outcomes by mode of delivery

Mode of delivery	Mother DRG	Number	Average cost Mother ($)	Baby DRG	Number	Average cost Baby ($)	Total average cost ($)
TOL Vaginal delivery	674	1552	1883	701		1095	
	675	322	2357	719		4885	
	676	85	2673	720		3186	
	688	3	3553	725		3195	
				726		2266	
				727		789	
Total		*1962*	*1998*			*393*	*2391*
TOL Emergency CS	670	1118	3791	701		1095	
	671	0	4367	719		4885	
	672	123	5215	720		3186	
	687	46	7033	725		3195	
				726		2266	
				727		789	
Total		*1287*	*4043*			*914*	*4957*
Total TOL		**3249**	**2808**			**599**	**3407**
Elective CS	670	2646	3791	701		1095	
	671	0	4367	719		4885	
	672	174	5215	720		3186	
	687	69	7033	725		3195	
				726		2266	
				727		789	
Total elective CS		**2889**	**3954**			**330**	**4284**

Note: The average cost incurred by neonates for each of the three delivery modes is calculated by dividing the total cost by the total number of babies born under each delivery mode, not the smaller number admitted to SCNN.

cost-effective alternative, by $782 per case, or 17.7 per cent. Analysis of the clinical literature in this area suggests that this represents a worst case scenario for TOL, in terms of success rate and costs incurred.

Conclusion

Economic analysis suggests that, for the health care system at least, TOL is the most cost-effective option of delivery for medically eligible women who have experienced CS prior to a current pregnancy. The cost advantage for the TOL

option over elective repeat CS is approximately 30 per cent for the sample studied. However, it should be noted that this is not the only reason why increased use of the TOL option may be encouraged. There are many other potential benefits of this option, to both mothers and their babies. For those achieving a successful vaginal birth, these could include decreased length of stay in hospital and more rapid postnatal recovery in general, increased probability of establishing a successful breast feeding regime (Cranley, Hedahl & Pegg 1983), decreased incidence of psychological morbidity (Enkin et al. 1995), and the satisfaction of both the achievement of a successful vaginal birth and the choice of a more 'natural' mode of delivery (Roberts et al. 1997). Even when TOL is unsuccessful, mothers may gain satisfaction from their choice to attempt a more natural birth.

However, it should be noted that there are additional reasons why TOL outcomes may be inferior to elective CS, especially if the TOL results in an emergency CS. These include increased length of stay, increased trauma and fatigue, and less satisfaction in the outcome of the birth experience (Roberts et al. 1997). Even when the TOL results in vaginal birth, this may be accompanied by an instrumental delivery, painful perineal sutures, and dissatisfaction with choice. Furthermore, some women may prefer the convenient timing aspects associated with elective CS.

In conclusion, this paper indicates substantial health care system resource savings due to TOL, but a comprehensive analysis of this issue must account for all of the above-mentioned factors. The likely additional costs that may be incurred by families and the probable impact on quality of life should be further explored, and research aimed at incorporating this broader range of costs and consequences into the analysis of the issue is currently under way.

Acknowledgements

The authors would like to acknowledge the assistance of Dr Warren Davis (Obstetrics and Gynaecology Staff Specialist, Illawarra Regional Hospital) for his significant part in the collection of data, and Mrs Helen Puris (Medical Record Manager, Shellharbour Hospital) and Tanya Baumer (Clinical Coder, Shellharbour Hospital) for their contribution to collection of DRG information. Thanks also to Dr Jane Hall for her valuable commentary on the project and two anonymous referees for their additional suggestions. The cooperation of the Illawarra Area Health Service in producing this report is acknowledged. However, the views expressed are solely those of the authors and do not necessarily reflect those of the health service.

Appendix 1

Criteria for exclusion from trial of labour

The following list has been applied to the data from the Illawarra Regional Hospital, Wollongong, after consultation with a number of obstetric specialists. The National Consensus Conference on Aspects of Caesarean Birth in Canada (1986) also provides a guide for exclusion criteria.

- Previous classical caesarean section incision
- Placenta praevia
- Proven maternal contracted pelvis
- Breech position (not absolute)
- Presence of lower uterine segment fibroid
- Previous repair for urinary incontinence
- Unstable lie (not absolute)

Appendix 2

DRG categories and average costs for maternal and neonatal hospitalisation, 1994–1995

AN-DRG category	Description	Average length of stay(days)	Total average cost ($)
670	CS W/O Complicating Diagnosis	6.0	3791
671	CS W Moderate Complicating Diagnosis	7.1	4367
672	CS W Severe Complicating Diagnosis	8.3	5215
674	Vaginal Delivery W/O Complicating Diagnosis	3.7	1883
675	Vaginal Delivery W Moderate Complicating Diagnosis	4.6	2357
676	Vaginal Delivery W Severe Complicating Diagnosis	5.1	2673
677	Vaginal Delivery W Complicating O.R. Procedures	5.6	3533
687	CS W Multiple Complicating Diagnosis (at least one severe)	11.7	7033
688	Vaginal Delivery W Multiple Complicating Diagnosis (at least one severe)	7.1	3553
701	Neonate, died/transferred <5 days of adm W/O Signf. O.R. Procedure, Born here	1.6	1095
719	Neonate Admission Wt 2000–2499g, W/O Signf O.R. Procedure W other problems	11.2	4885
720	Neonate Adm Wt 2000–2499g, W/OSignf. O.R. Procedure, W/O problems	6.2	3186
725	Neonate Adm Wt.>2499g W/O Signf O.R. Proc W Major problems	6.2	3195
726	Neonate Adm Wt.>2499g W/O Signf O.R. Procedure W other problems	4.1	2266
727	Neonate Adm Wt.>2499g W/O Signf O.R. Procedure W/O problems	3.5	789

Note: 1. Total average cost includes ward nursing, medical, pathology, theatre, imaging, medical-surgical supplies, catering, critical care, pharmacy and overheads.

Source: Commonwealth Department of Health and Family Services 1996, *Australian Casemix Report on Hospital Activity 1994–95,* Australian Government Publishing Service, Canberra.

Appendix 3

Allocation of data from other studies to AN-DRGs

In order to allocate the outcome data from the Lovell (1996) and McMahon et al. (1996) studies to DRG categories, several assumptions were made.

Women suffering more than one major complication were assumed to have suffered exactly two such complications, and coded to DRG 687 for vaginal births and 688 for CS. This enabled the number of women coded to DRG 676 and 672 respectively (one serious complication) to be imputed.

In the Lovell study, it is not possible to distinguish complication rates separately for successful vaginal births with and without instrumental delivery. Thus the overall rate of 9.6 per cent was applied to both groups, enabling allocation of women not suffering complication to either DRG 674 or DRG 675. Also, from the Lovell study, DRGs allocated to babies admitted to SCNN were estimated from the clinical data presented in Table 7 of Lovell's study (1996, p 6).

With respect to the study by McMahon et al. (1996), no information was provided on rates of instrumental delivery in the TOL (vaginal delivery) group. Hence an overall rate for Canada (1981) of 17.2 per cent was assumed (Lomas & Enkin 1989, p 1185). This is probably an upper bound estimate for these women, for whom there may be an increased tendency to proceed to CS rather than instrumental delivery once complications occur. As with the Lovell study (1996), complication rates (major and minor) reported in Table 4 of the McMahon et al. study (1996, p 694) were assumed to be the same for both instrumental and non-instrumental delivery.

Complications in the McMahon et al. study are regarded as either 'minor' or 'major'. However, from the perspective of Australian DRG coding, all should be viewed as 'major'. Hence all complications reported were coded to DRGs 676 (single) and 688 (multiple) in the case of vaginal births, and DRGs 672 (single) and 687 (multiple) in the case of CS.

References

Brown HS 1996, 'Physician demand for leisure: Implications for cesarean section rates', *Journal of Health Economics,* vol 15, pp 233–42.

Catanese M 1987, 'Vaginal birth after cesarean section: Recommendations, risks, realities, and the client's right to know', *Holistic Nursing Practice*, vol 2, no 1, pp 35–43.

Clark L, Mugford M & Paterson C 1991, 'How does the mode of delivery affect the cost of maternity care?' *British Journal of Obstetrics and Gynaecology*, vol 98, pp 519–23.

Commonwealth Department of Health and Family Services 1996, *Australian Casemix Report on Hospital Activity 1994–95*, Australian Government Publishing Service, Canberra.

Cranley M, Hedahl K & Pegg S 1983 'Women's perceptions of vaginal and cesarean deliveries', *Nursing Research*, vol 32, no 1, pp 10–15.

Enkin M 1989, 'Labour and delivery following previous caesarean section', *in* I Chalmers, M Enkin & MJNC Keirse, *Effective Care in Pregnancy and Childbirth*, Oxford University Press, vol 2, pp 1196–215.

Enkin M, Keirse MJNC, Renfrew M & Neilson J 1995, *A Guide to Effective Care in Pregnancy and Childbirth,* Oxford University Press, Oxford.

Gruber J & Owings M 1996, 'Physician incentives and cesarean section delivery', *RAND Journal of Economics,* vol 27, no 1, pp 99–123.

Hanley M, Smulian J, Lake M, McLean D & Vintzileous A 1996, 'Analysis of repeat cesarean delivery indication: Implications of heterogeneity, *American Journal of Obstetrics and Gynecology*, vol 175, no 4, pp 883–8.

Health Department of Victoria Ministerial Review of Birthing Services in Victoria 1990, *Having a Baby in Victoria,* Health Department Victoria, Melbourne.

Jonas O, Chan A & MacHarper T 1989, 'Caesarean section in South Australia, 1986', *Australian and New Zealand Journal of Obstetrics and Gynaecology*, vol 29, pp 99–106.

Keeler E & Brodie M 1993, 'Economic incentives in the choice between vaginal delivery and caesarean section', *The Milbank Quarterly*, vol 71, no 3, pp 365–404.

King J 1993, 'Obstetric intervention and the economic imperative', *British Journal of Obstetrics and Gynaecology*, vol 100, pp 303–6.

Lancaster P & Pedisich E 1993, *Caesarean Births in Australia*, Australian Institute of Health and Welfare National Perinatal Statistics Unit, Sydney.

Lilford R, Van Coeverden De Groot H, Moore P & Bingham P 1990, 'The relative risks of caesarean section and vaginal delivery: A detailed analysis to exclude the effects of medical disorders and other acute pre-existing physiological disturbances', *British Journal of Obstetrics and Gynaecology*, vol 97, pp 883–92.

Lomas J & Enkin M 1989, 'Variations in operative delivery rates', *in* I Chalmers, M Enkin & MJNC Keirse, *Effective Care in Pregnancy and Childbirth*, Oxford University Press, vol 2.

Lovell R 1996, 'Vaginal delivery after caesarean section: Factors influencing success rates', *Australian and New Zealand Journal of Obstetrics and Gynaecology*, vol 36, no 1, pp 4–8.

Maher C, Cave D & Haran 1994, 'Caesarean section reduced', *Australian and New Zealand Journal of Obstetrics and Gynaecology*, vol 34, no 4, pp 389–92.

McMahon M, Luther E, Bowes W & Olshan A 1996, 'Comparison of a trial of labour with an elective second cesarean section', *The New England Journal of Medicine*, vol 335, no 10, pp 689–95.

New South Wales Health Department 1996, 'New South Wales Midwives Data Collection 1995', *New South Wales Health Department Public Health Bulletin Supplement*, vol 7, no 2.

Norman P, Kostovcik S & Lanning A 1993, 'Elective repeat cesarean section: How many could be vaginal births?' *Canadian Medical Association Journal*, vol 149, no 4, pp 431–4.

Notzon FC, Placek PL & Taffel 1987, 'Comparisons of national caesarean section rates', *The New England Journal of Medicine*, vol 316, no 7, pp 386–9.

Paul R & Miller D 1995, 'Caesarean birth: How to reduce the rate', *American Journal of Obstetrics and Gynecology*, vol 172, no 6, pp 1903–11.

Roberts R, Bell H, Wall E, Moy J, Hess G & Bower H 1997, 'Trial of labor or repeated cesarean section: The woman's choice', *Archives of Family Medicine*, vol 6, pp 120–4.

Rouse D, Owen J, Goldenberg R & Cliver S 1996, 'The effectiveness and costs of elective cesarean delivery for fetal macrosomia diagnosed by ultrasound', *JAMA*, vol 276A, no 8, pp 1480–6.

Stephenson P 1992, *International Differences in the Use of Obstetrical Interventions*, World Health Organization European Regional Office, Copenhagen.

Wagner M 1994, *Pursuing the Birth Machine*: *The search for appropriate birth technology*, Ace Graphics, Camperdown, New South Wales.

Walton D, Ludlow D & Willis D 1993, 'Vaginal birth after caesarean section: Acceptance and outcome at a rural hospital', *Journal of Reproductive Medicine*, vol 38, no 9, pp 716–18.