Acta Genet Med Gemellol 39:361-369 (1990)

Sixth International Congress
on Twin Studies

The Cost Effectiveness of Preventing Preterm Delivery in Twin Pregnancies

E. Papiernik[1], L.G. Keith[2]

[1]*Department of Obstetrics and Gynecology, Baudelocque University Clinic, University René Descartes, Paris, France;* [2]*Department of Obstetrics and Gynecology, Northwestern University Medical School, and Prentice Women's Hospital and Maternity Center of Northwestern Memorial Hospital, Chicago, Illinois USA*

Abstract. As an extension of previous work on the risk of prematurity in singletons and on the social cost of twin births, an analysis has been carried out into the cost effectiveness of preventing premature delivery in twin pregnancies. The cost of prevention is assessed in terms of early diagnosis through ultrasound screening and of an extra 11 weeks of work leave to expectant mothers. When this cost is compared to the social cost involved in the transfer of newborns to neonatal intensity care units and in supporting handicapped children, it is concluded that the total cost of prevention corresponds to one-third of the long-term costs associated to lack of prevention.

Key words: Twin pregnancy, Preterm delivery, Cost effectiveness, Prevention

INTRODUCTION

Obstetricians generally are aware of the high-risk nature of twin pregnancy. This risk is characterized by increases in the frequencies of specific complications, such as anemia, polyhydramnios, toxemia, preterm delivery (<37 weeks) and postpartum hemorrhage [5]. Whereas the poor obstetrical outcome of multifetal pregnancy is well known, clinicians often do not consider the magnitude of these outcomes in terms of lives lost or diminished quality of life as a result of handicaps. They also do not consider the costs of these problems [9,15].

Of the five major medical risks associated with twin pregnancy, one — namely, the increased rate of preterm birth — accounts for the vast majority of problems and their related costs. It is paradoxical that simple preventive measures designed to reduce the rate of the most dangerous preterm births may not be applied because they are considered too costly [9]. Nonetheless, society is obliged to deal with the expenditures required to compensate for preterm delivery; moreover, these costs are borne by all of society — not only the parents of the twins [15]. This statement is true regardless of the source of funds used for medical reimbursement. Stated another way, the specific risk of preterm delivery in twin pregnancies accounts for expenditures vastly out of proportion with the prevalence of twinning.

The purpose of this paper is to show that programs designed to prevent the very early preterm delivery in twin pregnancies or to shift a proportion of infants away from the very low birth weight (VLBW) category toward higher weight categories are cost effective. The major aim of such programs is to reduce the need for admission to the neonatal intensive care unit (NICU) and diminish the subsequent risk of handicap among very early twin births — mostly 26-31 weeks. The vast proportion of these infants weigh less than 1500 g at delivery and require prolonged stays in the NICU. The chance of delivering two twin infants in this weight category is 10 times higher compared to singleton births (see below), and this risk is vastly increased for triplets and higher order multiple pregnancies. Given these circumstances, even a slight modification of the naturally occurring distributions of gestational duration or birth weights can have an enormous effect in terms of outcome — measured either as cost or quality of life. This concept was initially proposed in France some 10 years ago [5] and subsequently has been the subject of additional commentary [9,11,15]. Data are now available from different obstetrical units [7,12] including the Hôpital Antoine Béclère [15] in Clamart, France, to demonstrate that it is possible to affect such a change.

METHODS AND PATIENTS

Background

There are five basic elements to the special costs associated with twin pregnancies. These are, in chronological order of expenditure: 1) screening for diagnosis; 2) prevention of preterm birth; 3) transfer of newborns to the neonatal intensive care unit; 4) long-term care of developmental and physical handicaps; and 5) avoidance of twin pregnancies. This latter item will not be discussed further, because it will be the topic of additional papers which will examine some of the reasons underlying the increasing numbers of multiple gestastions. Because the potential for the cost of care provided to handicapped individuals only pertains to survivors, calculations will delineate those costs which pertain to the mother and her infants prior to birth and those which pertain to the care provided to infants after birth.

The four elements of cost cited above are related to the naturally high rate of preterm delivery among twin gestations. Preterm delivery (< 37 weeks) occurs in about 45% of twin pregnancies. National variations in this rate depend on a variety of factors, including local conditions, accuracy of reporting, and possibly, racial variation [6,7,12]. Of great importance is the fact that distribution of twin birth weight is skewed toward very low birth-weight infants (Table 1). The consequences of the high rate of preterm delivery among twins and the skewed birth-weight distribution are directly related to immediate as well as later outcome. Indeed, need for NICU transfer, length of newborn stay (LOS), survival probability, and subsequent risk of handicap are all related to birth-weight categories with no major differences between twins and singletons (Table 2). Aside from specific medical indications, or the need for neonatal resuscitation, the decision to transfer a newborn (singleton or twin) to the NICU is as closely related to birth weight as to gestational age.

Table 1 - Distribution of birth weights per 1000 births

Birth weight (g)	Twins	Singletons
≤1000	40	2
1001-1500	65	6
1501-2500	425	35
2501+	470	957

This table presents a mean distribution of birth weights for twin gestations derived from several data sets [1,2,12].

The birth-weight distribution shown in Table 1 and the transfer rate and duration of stay shown in Table 2 permit calculation of the comparative need for neonatal intensive care beds (per 1000 births) for twins and singletons (Table 3). This difference in these values is more than striking. Twins require 11.4 times the NICU days of singletons.

Among survivors, the handicap rate can be derived in a similar fashion. Using the distributions by weight class in Table 1, plus the newborn survival rate and the handicap risk depicted in Table 2, the differential in numbers of handicapped children between singletons and twins is shown in Table 4.

Table 2 - Transfer rate, length of stay (LOS), survival and handicap risk by birth weight

Birth weight (g)	Transfer rate (%)	Length of stay in NICU[a] days	Survival /1000	Risk for handicap/1000 survivors
≤1000	100	35.1	600	200
1001-1500	80	30.5	900	100
1501-2500	20	13.4	980	10
2501+	1	4.8	998	1

Data on transfers and LOS were collected in the 1970s on a geographically defined population in the Northeastern United Kingdom [13]; the survival data and risk of handicap are derived from the literature [3,14,16].

[a] NICU: Neonatal intensive care unit.

Table 3 - Need for neonatal intensive care (bed days) per 1000 twin births vs 1000 singleton births

Birth weight (g)	Twin bed days	Singleton bed days
≤1000	1404	70
1001-1500	1586	152
1501-2500	1156	96
2500+	22	48
Total	4168	366

This table shows the number of bed days needed for twins compared to singletons, based upon the observed difference in birth weight distribution (about 11 times more bed days are needed for twins).

Table 4 - Number of handicapped children per 1000 births

Birth weight (g)	Twins	Singletons
≤1000	4.8	0.16
1001-1500	5.9	0.54
1501-2500	4.2	0.34
2500+	0.4	0.95
Total	15.3	1.99

This table shows the proportion of handicapped children expected per 1000 twin births compared to 1000 single births and is related to the difference in birth-weight distribution between twins and singletons.

The Hypothesis That Prevention Was Possible

The preceding tables were constructed using data from the 1970s. In 1979, Héluin et al [5] proposed that it would be possible to modify the skewed distribution of twin birth weights and thereby result in a substantial reduction of the risk for preterm delivery, NICU transfers and days of NICU bed use, and neonatal mortality.

This proposal was based on techniques developed in France to reduce the rate of preterm deliveries in singleton pregnancies [13]. The principles of the program included, on the one hand, educating each woman on the specific risk factors for preterm delivery that pertained to her lifestyle and pregnancy, and, on the other hand, proposing significant reductions in the physical efforts of daily life.

In order to accomplish this latter goal, attention was focused not only on household and domestic arrangements, but on obtaining a medically prescribed leave of absence from paid labor outside the home with financial compensation to augment the traditional maternity leave provided in France for the past several decades. Because it was recognized that twin pregnancies were at risk of " early " preterm labor from the 26th week

https://doi.org/10.1017/S0001566000005286 Published online by Cambridge University Press

up, a programmatic decision was made to request medically prescribed work leave to begin as early as possible, for example, between the 20th and 24th week. As was the case with singletons, this work leave include financial compensation for lost wages. In order that medical prescriptions for work leave could be applied effectively, it was important to have an accurate diagnosis of twin gestation by the 20th week.

Although, the routine use of ultrasound had not been advocated specifically for the diagnosis of twins, as had been the case in Sweden [11], it was performed in every case in order to obtain a better definition of term and to avoid problems stemming from post-term delivery.

The policy was tested in the maternity unit of a teaching hospital located outside Paris. Patients were recruited early in pregnancy. A portion of the women had come for their initial visit before knowing that they had twins. Others came after a diagnosis of twin pregnancy had been made in private practices or in other obstetric hospitals. The study group did not include women referred to the unit late in pregnancy because of complications.

Two different levels of effectiveness were expected. Both were based on the concept that preventive techniques could reduce the rate of preterm birth and produce a distribution of birth weights more closely approximating that of singletons. The first hypothesis (A) aimed at a modest reduction in VLBW (< 1000 and 1001-1500 g) infants. The second hypothesis (B) aimed at a more significant reduction in these birth weight categories. With the available data, we could calculate expected number of days in the NICU and the number of handicapped children if either *Effect A* or *Effect B* would be affected (Table 5).

Table 5 - Observed (1979) and expected numbers of NICU[a] days and handicapped children with preventive " effect " A or B

	Observed 1979	Expected	
		Effect A	Effect B
Number of days in NICU per 1000 births	4168	2524	1675
Number of handicapped children per 1000 births	15.3	8.77	6.21

[a] NICU: Neonatal intensive care unit.

At the time these hypotheses were formulated, we elected to use birth weight rather than gestational age categories in the calculation, both for the question of costs and for the estimation of the rate of handicaps. This decision was based on the fact that published literature at that time only rarely was concerned with the accurate estimation of gestational age. In contrast, virtually all reports categorized infants by their birth weight. Were these hypotheses to be formulated today, the question of gestational age would be treated differently. We are now able to look at the problems of birth weight, gestational age and costs as parts of an interrelated continuum. Previously, however, this concept was not well appreciated. Notwithstanding this caveat, the measurement tools available today focus on the reduction of the number of infants born at < 31 weeks of gestation or weighing < 1500 g.

RESULTS

Data obtained from 321 twin deliveries (excluding fetuses < 500 g) followed at Clamart Hospital between 1982 and 1988 are shown in Tables 6 and 7. Table 6 shows the actual birth-weight distribution for twins during the study alongside the benefits from " Effect " A or " Effect " B, respectively, and the previously cited distribution of birth weights derived from the literature. Table 7 gives additional information on these twin births including the perinatal death rate of 30/1000. This figure includes infants of all weight categories > 500 g and terminates at the 28th day of extrauterine life. During the study period, the total rate of transfer to the NICU was 13.3%.

Table 6 - Results from " effect " A or B compared with published birth-weight distribution as of 1979 (per 1000 births) and observed distribution in Clamart

Birth weight (g)	Published distribution (%)	Expected distribution of birth weights (%)		Observed distribution of birth weights (%)
		Effect A twins	Effect B twins	Clamart, 1982-1988
⩽1000	40	20	10	17
1001-1500	65	40	25	30
1501-2500	425	300	250	433
2500+	470	640	715	518

Table 7 - Perinatal deaths and NICU transfers by birth-weight category: Clamart maternity, 1982-1988

Birth weight (g)	Twin births		Perinatal deaths		NICU transfers
	N	%	SB	NND	
500-999	11	17	1	3	4
1000-1499	19	30	2	2	8
1500-2499	277	433	3	4	58
2500+	332	518	2	3	16
Total	642	1000	8 (12.5/1000)	12 (18.7/1000)	86 (13.3%)

NICU: Neonatal intensive care unit; SB: Stillbirth; NND: Neonatal death.

Cost Estimations

The following costs were estimated: 1) a single screening ultrasound between 10 and 20 weeks; 2) the cost of work leave if all women are employed, by week of commencement of work leave; 3) the cost per NICU hospital day; and 4) approximation of the long-term costs for each handicapped child [4].

The two main expenses for prevention are: 1) the ultrasound provided all pregnant women at the end of the first trimester; and 2) the prophylactic work leave with financial compensation provided to all mothers of twins after the 24th week LMP. Similar approximations can be calculated for cost of care in the NICU and for long-term care for surviving handicapped children.

Cost of Early Diagnosis of Twinning

If the total cost of this policy is transferred to the detection of twinning, this is an overstatement of cost. Nonetheless, one scan in France costs 300F ($50). Because the proportion of twin pregnancies is about 1/100, a total of 100 scans are required to diagnosis one twin gestation. The cost, therefore, is 300 × 100 = 30,000F ($5,000). For 1000 births of twins, the cost will be 500 times greater: 30,000F × 500 = 15,000,000F ($5,000 × 500 = $2,500,000).

Cost of Work Leave Beginning at 24 Weeks

If work leave is provided after 24 weeks for all pregnant mothers of twins, this represents an 11-week supplement to the work leave normally provided in France for all pregnant working women starting at 35 weeks. If we accept that all women are employed outside their homes, and that all took the extended leave, the calculated cost also represents an overstatement of true cost. The mean compensation for one week of work leave is approximately 2000F ($333). For every pregnant mother of twins, the additional cost is 2000F × 11 = 22,000F ($3,600). For 1000 twin births (500 pregnancies), the cost is 22,000 × 500 = 11,000,000F ($1,800,000). Thus, the estimated cost of the preventive policy is:

Cost of scans	15×10^6F		$\$2.5 \times 10^6$
Cost of work leave	11×10^6F	or	$\$1.8 \times 10^6$
Total costs	26×10^6F		$\$4.3 \times 10^6$

Savings Estimations

Money can be saved by the reduction in NICU transfers and it duration of stay. In France, the mean cost for a NICU day is about 6000F ($1000). Policy B would achieve a saving of $4168-1675=2493$ days for 1000 births of twin babies. The monetary equivalent of this projected saving is 2493×6000FF $= 15 \times 10^6$F or $\$2.5 \times 10^6$.

If policy B is successful, the number of handicapped children per 1000 twin births drops by 9, from 15 (Table 4) to 6 (Table 5). The present monetary value of life-long support of a handicapped person in France is considered about 7×10^6F ($\$1.1 \times 10^6$). The approximate savings per 1000 twin births would be $9 \times 7 \times 10^6\text{F} = 63 \times 10^6$F (or in US currency $9 \times 1.1 \times 10^6 = \$9.9 \times 10^6$).

In sum, the total monetary saving would include the following:

NICU reduction	15×10^6F		$\$2.5 \times 10^6$
Reduction in handicaps	63×10^6F	or	$\$9.9 \times 10^6$
Total savings	78×10^6F		$\$12.4 \times 10^6$

The balance between costs and savings are shown as follows:

Costs			
Scans	15×10^6F		$\$2.5 \times 10^6$
Work leave	11×10^6F	or	$\$1.8 \times 10^6$
Total	26×10^6F		$\$4.3 \times 10^6$

Savings			
NICU	15×10^6F		$\$2.5 \times 10^6$
Handicaps	63×10^6F	or	$\$9.9 \times 10^6$
Total	78×10^6		$\$12.4 \times 10^6$

These data show that more than half of the cost of the proposed preventive policy would be compensated in the very short term by a reduction in costs related to the transfer of newborns to a NICU. This calculation substantially reduces the difficulty in accepting a proposal to spend money now to save money many years later. When the potential savings in expenditures related to handicap are considered, the immediate cost of prevention (including work leave) can be assessed vis-a-vis long-term savings. Stated simply, the total cost of prevention is but 1/3 of the long-term costs associated with lack of prevention.

The policies proposed in 1979 and carried out since did not include calculations to determine the numbers of lives saved. However, as seen in Table 6, the perinatal death rate of 30/1000 is well below many published results of the 1970s and much lower than many national figures for twin births in developed countries.

COMMENTS

The data presented above are drawn from diverse sources. Their amalgamation permits the obstetrician to view the problem of the cost of preterm delivery in twin pregnancy in a more comprehensive manner. This approach is necessary if one wants to understand the relationship between simple changes in the delivery of prenatal care and the outcome months and years later.

There is no accepted manner to calculate costs for multiple pregnancy. Estimates differ from country to country and depend on a variety of factors, many of which differ markedly depending on levels of available technology.

Our interest in the cost of preventing preterm delivery is a logical extension of work begun in 1969 for single pregnancies [8] and in 1979 for twins and proven to be effective in 1983. The theme has particular relevance in 1990 when obstetricians are beginning to discuss the effects of the epidemic of multiple pregnancies throughout the world.

REFERENCES

1. Bleker OP, Breuer W, Huidekoper BL (1979): A study of birth weight, placental weight and mortality of twins as compared to singletons. Br J Obstet Gynaecol 86:111-118.
2. Doring GK, Hossfeld CG, Auer A (1978): Ueber die Risiken der Zwillings-Schwangerschaft und Geburts. Geburtsch Frauenheilkd 38:516-524.
3. Erhenhaft PM, Wagner JL, Herdman RC (1989): Changing prognosis for very low birth weight infants. Obstet Gynecol 74:528-535.
4. Ewald U (1988): What is the cost of neonatal intensive care. Report of the State of the Art Conference on Neonatal Intensive Care. The Swedish Medical Research Committee, June 12-15, 1988. Personal communication.
5. Héluin G, Bessis R, Papiernik E (1979): Clinical management of twin pregnancies. Acta Genet Med Gemellol 28:333-336.
6. Lowry MF, Stafford J (1988): Northern region twin survey 1984. J Obstet Gynecol 8:228-234.
7. Osborne GH, Patel NB (1985): An assessment of perinatal mortality in twin pregnancies in Dundee. Acta Genet Med Gemellol 34:193-199.
8. Papiernik E (1969): Le coefficient de risque d'accouchement prématuré (CRAP). Presse Med 77:793-794.
9. Papiernik E (1983): Social costs of twin births. Acta Genet Med Gemellol 32: 105-111.
10. Papiernik E, Keith LG, Bouyer J, Dreyfus J, Lazar P (1989): Effective prevention of preterm birth: The French experiences measured at Haugueneau. Birth Defects Orig Art Ser 25.
11. Persson PH, Grennert L (1969): Toward normalization of twin pregnancy. Acta Genet Med Gemellol 28:341-346.
12. Scholtes G (1977): Ueberwachung und Betreibung der Mehrlingschwangerschaften. Geburtsh Frauenheilkd 37:747-755.
13. Simpson H, Walker G (1981): Estimating the costs required for neonatal intensive care. Arch Dis Child 56:90-93.
14. Stewart AL, Reynolds EOR, Lipscomb AP (1981): Outcome for infants of very low birth weight. Survey of the world literature. Lancet 1:1038-1041.
15. Tresmontant R, Héluin G, Papiernik E (1983): Cost of care and prevention of preterm births in twin pregnancies. Acta Genet Med Gemellol 32:99-103.
16. United States Office of Technical Assessment (1988): Healthy Children: Investing in the Future. OTA H 345. Washington, DC: US Government Printing Office.

Correspondence: Professor Emile Papiernik, Department of Obstetrics and Gynecology, Baudelocque Clinic, René Descartes University, 123 Bd. de Port Royal, F-75014 Paris, France.