Sudden infant death syndrome in New Zealand: are risk scores useful?

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Abstract

Study objective – To evaluate the Christchurch, Invercargill, Dunedin (CID) and Oxford record linkage study (ORLS) risk scores in five regions of New Zealand and examine the effect of risk factors for sudden infant death syndrome (SIDS), such as prone sleeping position, maternal smoking, breast feeding, measures of illness, the use of antenatal classes, community health care, and medical services on a high and low risk group delineated by the CID score.

Design – This was a case-control study of infants dying of SIDS.

Setting – Both the cases and controls were born in one of five health districts in New Zealand and their parents were interviewed between 1 November 1987 and 31 October 1990.

Participants – The cases were 485 infants who died of SIDS. The controls were a random sample drawn from the same five regions in which the cases were born, chosen so that their age on the day on which they were interviewed was similar to the age at death of the cases. Risk scores were calculated for 387 case and 1579 controls.

Measurements and main results – Using the recommended cut off points the sensitivity and specificity of the CID and ORLS were found to be similar to those described for other samples. The differences among the regions were significant. There was, however, no evidence that the association between SIDS and the risk factors considered was different in the high and low risk groups delineated by the CID score. The relative attributable risk for smoking was 32.3% in the high risk group. The excess risk that could be attributed to a different prevalence of any of the other risk factors in the high risk group was small when compared with the low risk group.

Conclusions – Health care resources should be spent on promoting and evaluating good child care practices for all, rather than identifying and promoting special interventions for those in the high risk category.

have tended to focus on child care practices and factors in the home, identifying factors such as sleep position, breast feeding, thermal environment of the infant, and parental smoking as being important. Rather than concentrate on the evaluation or construction of risk scores, these studies have more directly examined behaviours which are amenable to change.¹⁻⁴ Earlier research based predominantly on retrospective data, often derived from hospital records or community health clinics, developed a number of scoring systems which identified infants who were believed to be at particularly high risk of dying of SIDS.⁵⁻⁷ Recent prospective studies have been able to utilise more information about aspects of the family life and child care practices in the home, thereby specifically identifying risk behaviours.

Despite what seems to be a successful whole-population approach to reducing the incidence of SIDS by modifying sleep position, the difficulty that this may entail for some parents, it has been argued, may justify exploring other factors that may reduce risk.⁸ The possible benefits of having health workers visit those at high risk may be one of these. Another possibility is the use of a scoring system devised by Morley *et al.*,⁹ which can be used by parents or health care workers to detect serious illness. It has also been noted that in countries which endeavour to optimise the environment of babies and mothers before and after birth the rate of infant mortality including SIDS is low.⁸ Earlier research addressed some of these issues by identifying those believed to be most at risk of SIDS with a series of scoring systems.

The Oxford record linkage study (ORLS) score, when tested on a British cohort sample, was compared with scores from Sheffield, Cardiff, and California and was found to have the best positive predictive value.¹⁰ Despite this, many advocate scoring systems specific to individual regions. Because southern New Zealand had such a high SIDS rate – 6.3 per 1000 live births in the period 1979–84 – a case-control study was carried out in the Christchurch, Invercargill, and Dunedin Health (CID) districts to develop a scoring system for the South Island.¹¹ The score was based upon four risk factors: mother's age, marital status, parity, and birth weight, all information that was available in the immediate postnatal period. The positive predictive value of the CID score and the ORLS score were similar both for the sample on which the CID score was based and a subsequent series of SIDS.¹¹ The New Zealand cot death study provided an opportunity to evaluate both scor-

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Accepted for publication
May 1994

(J Epidemiol Community Health 1995;49:94-101)

Recent epidemiological studies on the sudden infant death syndrome (SIDS or cot death)

ing systems and compare their differences in five regions in New Zealand.

Risk scores were never believed to be causally related to cot death but rather to identify those most at risk. It is reasonable to ask, therefore, whether they continue to play a useful role in public health campaigns to reduce the incidence of SIDS. Ideally, the use of a risk score should be evaluated with a prospective study; however, the data collected as part of the New Zealand national cot death study afforded an opportunity to compare the role of a number of factors among those at high and low risk. If risk status were found to be an effect modifier – that is, risk factors were related causally to death in a different way for those at high and low risk – it could be argued that the use of a risk score was worth while because strategies could be put in place to ameliorate the effect of being in a particular group. The CID risk score has again been compared with the ORLS. It was then used to divide the children into high and low risk groups so that the effect of other risk factors, such as sleep position, smoking in the home, lack of breast feeding, and measures of illness and the use of health care services in infancy, can be compared.

Methods

The sample was drawn from health districts in Auckland, the central North Island, southern North Island, Christchurch, and southern South Island. During the study period from 1 November 1987 to 31 October 1990, 78% of all New Zealand live births were reported from this area. Infants who died between the age of 28 days and 1 year (the post neonatal period) were enrolled in the study if they had a diagnosis of SIDS, with or without other abnormalities. Cases were identified by autopsies carried out by regional pathologists in consultation with a local paediatrician according to an agreed protocol. Cases about which there was uncertainty were reviewed by the study pathologist. The controls were randomly selected from all births, except home births, in the study area. The protocol by which the cases were identified and how the control group was selected has been described in full elsewhere.¹²

The parents of both the cases and the controls were interviewed on a wide range of topics, including child care practices, minor illnesses, and their use of health services. As the period before death was of particular interest for the cases, the controls were asked about a time on a nominated day, randomly assigned so that the distribution of this among the controls reflected the estimated distribution of the time and day of death among the cases. Data, including race, relating to the antenatal and perinatal period were derived from the obstetric records.

During the three year period there were 485 SIDS deaths; a rate of 3.53 per 1000 live births. This study was based upon the 387 (79.8%) cases for whom almost complete data were available, in particular data from the home interview. Data were available for 1579 (89.6%) infants in the control group.

The CID score was derived by summing weights for four items, the mother's age and marital status, birth weight of the child, and parity.¹¹ The modified ORLS score was rather more complex and was derived by multiplying weights for social class, mother's marital status, an interaction effect between the mother's age and birth order, interval from last pregnancy to this conception, date of last menstrual period known, smoking during pregnancy, infection during pregnancy, month of delivery, sex of infant, gestation, and multiple birth. Items relating to drug addiction, barbiturate use, and congenital defects were excluded because they were not available. The item for a previous sudden infant death was replaced by a previous post neonatal death. Some items were missing for some cases and these were assigned a score of 1.¹⁰ The Elley and Irving¹² measure of socioeconomic status derived for use in New Zealand was used to classify the father's and mother's occupations. The higher classification was used as a measure of social class. The weights for month of birth were adjusted to reflect the seasons in the southern hemisphere. Cut off scores of 350 or more on the CID score and 2 or more on the ORLS were used to identify those at high risk.^{11 13}

Information on the infant's sleep position, breast feeding, maternal smoking, and bed sharing as well as use of health services was obtained as part of the interview. Information on breast feeding at discharge from hospital was obtained from the obstetric records.

A series of scores representing illnesses or problems thought to be associated with SIDS were derived from the data collected during the interview. A score for infections in the last two days was formed by summing items related to minor infections such as coughs, colds, feverishness, less urine than usual, and others describing the use of paracetamol and cough mixture. The score was then classified as none, 1 or 2, or >2 to provide an indication of the level of illness. A reactivity score was based upon information relating to the appearance and behaviour of the baby and included questions about irritability, floppiness, whether the infants were interested in feeding, and questions about how sleepy or difficult to arouse the baby seemed to be. This was classified as normal and low, representing babies whose reactivity was below normal. Respiratory symptoms were based on a series of questions relating to the occurrence of respiratory tract infections in the infants or their families in the last two weeks; this was divided into two groups – none and 1 or more. The severity of illness score was based upon the baby check system,⁹ using the following items: vomit or spill more than 30 minutes after a feed, quantity of urine less than usual, severe nappy rash in the last two weeks, and a series of symptoms relating to the last two days, namely, long periods of wakefulness or more difficult to arouse than usual, off feeds, a change of cry as if in pain, more floppy than usual, cough or wheeze. A report of the baby being hot or feverish replaced a finding of a rectal temperature greater than 38°C. The remaining items of the baby check

system were not available. The cut off points were similar to those described in the original score and allowed infants to be classified as having mild or no symptoms, symptoms which required advice, or symptoms severe enough to suggest that the infant should have been seen by a medical practitioner. A variable for sweating was based upon questions asking whether the baby had ever been drenched in sweat while asleep and allowed these to be classified as never, once, or twice or more than once a week. All these scores were found to be associated with SIDS.

Ethical approval for this study was obtained from local ethics committees.

STATISTICAL METHODS

Odds ratios and their 95% confidence intervals (95% CI) were computed for the risk factors within each group. Interaction effects between groups were compared using the Thomas extension of the Mantel Haenszel test.¹⁵ Odds ratios whose 95% CI exclude 1 can be regarded as statistically significant ($p<0.5$); however, they should be interpreted with care because a large number of tests have been performed. The population attributable risk (AR), which represents the proportion of the cases occurring in the total population that can be explained by a risk factor, was also calculated. The relative attributable risk (RAR) was used to estimate the percentage of excess risk of SIDS among the high risk group that could be attributed to their higher exposure to a risk factor, compared with the low risk group.¹⁵ Neither the AR nor the RAR were adjusted for confounding factors so they could be altered if adjustments were made. Kappa and its 95% CI were used to assess the level of agreement between those identified as high and low risk by the two scores.¹⁶

Results

It was possible to calculate the CID risk score for 387 cases and 1579 controls. Comparisons were made for three items of the CID risk score for those with a risk score and the 78 cases and 183 controls without. For the cases, the mean (SD) birth weight was 3063 g (700.7) for those included and 2969 g (676.2) for the remainder.

This difference was not statistically significant. The difference between the mother's age was significant ($p=0.02$); the means were 25.2 years (5.06) for those included and 23.8 (4.87) for the rest. For the controls the birth weights for the two groups were 3438 g (566.4) and 3377 g (600.7). The difference was not statistically different, but the difference in the mothers' age was significant ($p<0.001$). Again, the mothers of those with a risk score were older than the mothers of those without. The mean ages were 27.8 (5.26) and 25.9 years (5.67). There was no difference between those included and those excluded for parity for either the cases or the controls. It was not possible to make comparison for the mothers' marital status because that was collected at the time of the interview and data were not available for most of those not included in this study.

The mean scores for the subjects included in the control group for the five regions and the whole of the sample for both the CID and the modified ORLS scores are shown in table 1. The overall mean for the CID score was 291.2. The recommended cut off point of 350 identified 18.0% of the controls, 54.3 of the cases as high risk. When the regions were compared the differences in the controls for the overall score was statistically significant ($p<0.001$). There were also differences in the number of subjects identified as high risk; the Christchurch area had only 8.7% of controls designated as high risk while the central North Island had 23.4% of controls. The Dunedin/Invercargill area had the lowest proportion of high risk cases (40%) and the Auckland area the highest (58.8%). The association between being at high risk and dying of SIDS was strong; the odds ratio was 5.54 (95% CI 4.32, 7.11). The mean score for the modified ORLS was 0.532; the recommended cut off point of 2 identified 18.7% of the controls as high risk and 56.0% of the cases. There were regional differences for this score too, though when those above and below the cut off were considered they were less marked, identifying 15.0% of controls in the lower North Island compared with 24.5% in the central North Island. The differences in the proportion of cases identified were slightly more pronounced, the highest being 63.4% in the central North Island compared with only 42% in the

Table 1 Mean score for controls and percentage of cases and controls above cut off points for the Christchurch, Invercargill, and Dunedin (CID) and Oxford record linkage study (ORLS) scores

	Mean	% above cut off		Odds ratio	(95 CI)
		Cases	Controls		
CID:					
Auckland	288.5	58.8	17.6	6.67	(4.22, 10.58)
Central North Island	301.4	58.5	23.4	4.60	(2.97, 7.13)
Lower North Island	288.0	48.0	15.5	5.01	(2.47, 10.19)
Christchurch	276.7	54.0	8.6	12.52	(5.45, 29.15)
Dunedin/Invercargill	290.5	40.0	17.5	3.15	(1.48, 6.67)
Total	291.2	54.3	18.0	5.54	(4.32, 7.11)
ORLS:					
Auckland	0.463*	56.6	16.8	6.45	(4.08, 10.24)
Central North Island	0.662	63.4	25.4	5.09	(3.27, 7.92)
Lower North Island	0.451	54.0	12.6	8.14	(3.93, 16.94)
Christchurch	0.574	46.0	14.9	4.88	(2.30, 10.38)
Dunedin/Invercargill	0.517	48.0	18.1	4.18	(2.01, 8.76)
Total	0.532	56.0	18.7	5.59	(4.41, 7.24)

* Geometric means have been calculated for the ORLS score.

Dunedin/Invercargill area. The association between being high or low risk and SIDS was similar to that of the CID score 5.59 (95% CI 4.41, 7.24). The odds ratios for each region for being a SIDS is shown; clearly those in the high risk group have an increased risk of dying. Overall, the positive predictive value was 6.0 per 1000 for both the CID and the modified ORLS scores. The agreement measured by kappa between those designated high and low

Table 2 Frequencies as percentages, mean (SD) for demographic data, birth weight, gestational age, and time of death or interview for high and low risk groups defined by the Christchurch, Invercargill, and Dunedin (CID) score

	Low risk					High risk				
	Cases (n=177)		Controls (n=1294)		p*	Cases (n=210)		Controls (n=285)		p*
Sex (male)	106	59.9	665	51.4	0.04	126	60.0	134	47.0	0.04
Mother married	140	79.1	1138	87.9	0.002	30	14.3	35	12.8	0.27
Ethnic group:										
Maori	53	29.9	150	11.6	<0.001	124	59.1	145	50.9	0.16
Pacific Island	9	5.1	111	8.6		13	6.2	26	9.1	
Other	115	64.9	1033	79.8		73	34.7	114	40.0	
Socioeconomic class:										
I, II	47	26.7	515	39.8	<0.001	24	11.4	25	8.8	0.16
III, IV	86	48.8	605	46.8		88	41.9	143	50.4	
V, VI, and others	43	24.4	174	13.5		98	46.7	116	40.9	
Birth weight (kg)	3.3	5.12	3.5	5.11	<0.001	2.8	7.55	3.2	7.13	<0.001
Gestational age (wk)	39.3	1.74	39.8	1.44	<0.001	37.8	3.25	39.1	2.62	<0.001
Mother's age (y)	28.8	3.92	29.1	4.64	0.38	22.2	3.79	22.0	3.66	0.44
Age at death/interview (wk)	14.8	9.29	17.0	10.61	0.008	15.2	9.09	16.4	10.38	0.17

* p value for χ^2 test or analysis of variance comparing the cases and controls in each risk group.

Table 3 Frequencies as percentages, odds ratios, and 95% CI intervals for modifiable risk factors for infants in low and high risk groups defined by the Christchurch, Invercargill, and Dunedin (CID) score

	Low risk					High risk				
	Cases (n=177)	Controls (n=1294)	Odds ratio	(95% CI)	AR	Cases (n=210)	Controls (n=285)	Odds ratio	(95% CI)	AR
Prone sleep position	64.4	33.6	4.59	(3.22, 6.56)	54.6	60.2	30.3	3.49	(2.35, 5.18)	43.0
Lack of breast feeding on discharge from hospital	29.0	14.2	2.46	(1.69, 3.39)	17.1	33.8	17.9	2.34	(1.51, 3.63)	19.3
Bed sharing	11.3	8.7	1.34	(0.78, 2.27)	2.9	34.6	18.1	2.40	(1.54, 2.40)	20.2
Maternal smoking:										
None	51.4	75.1	1.00		30.6	18.6	36.1	1.00		48.6
1-19	31.7	18.9	2.35	(1.76, 3.15)		55.2	48.4	2.22	(1.39, 3.54)	
20 or more	17.0	6.0	4.10	(2.49, 6.75)		26.2	15.4	3.30	(1.85, 5.89)	

AR=attributable risk.

Table 4 Frequencies as percentages, odds ratios, and 95% CI for infections and illnesses for infants in low and high risk groups defined by the Christchurch, Invercargill, and Dunedin (CID) score

	Low risk					High risk				
	Cases (n=177)	Controls (n=1294)	Odds ratio	(95% CI)	AR	Cases (n=210)	Controls (n=285)	Odds ratio	(95% CI)	AR
Infections:										
None	44.4	45.2	1.00		1.5	33.2	33.7	1.00		1.4
1 or 2	39.5	41.4	0.97	(0.67, 1.41)		48.6	45.6	1.08	(0.69, 1.70)	
>2	16.1	13.4	1.21	(0.73, 2.02)		18.2	20.7	0.89	(0.50, 1.60)	
Reactivity less than normal	19.5	6.4	1.71	(0.96, 3.02)	4.3	12.7	7.7	1.74	(0.90, 3.34)	7.2
Severity of illness										
Mild or none	80.0	89.3	1.00		10.5	76.3	83.3	1.00		8.5
Needs advice	15.0	8.8	1.90	(1.14, 3.14)		16.0	11.7	1.49	(0.90, 2.67)	
Needs to be seen	5.0	1.9	3.00	(1.21, 7.22)		7.7	4.9	1.72	(0.73, 4.02)	
Sweating:										
None	75.6	85.3	1.00		11.3	64.4	77.5	1.00		16.8
1 or 2	12.5	9.7	1.45	(0.87, 2.43)		16.4	12.7	1.55	(0.90, 2.67)	
At least weekly	11.9	5.0	2.67	(1.53, 4.64)		19.2	9.9	2.34	(1.34, 4.12)	
Respiratory symptoms:										
None	22.0	30.3	1.00		11.1	17.2	17.0	1.00		11.1
≥1	78.0	69.7	0.96	(0.65, 1.42)		82.9	83.1	1.15	(0.77, 1.69)	

AR=attributable risk.

Table 5 Frequencies as percentages, odds ratios, and 95% CI for use of health services for high and low risk groups defined by the Christchurch, Invercargill, and Dunedin (CID) score

	Low risk					High risk				
	Cases	Controls	Odds ratio	(95% CI)	AR	Cases	Controls	Odds ratio	(95% CI)	AR
Not had 6 week check	10.9	5.1	2.30	(1.25, 4.18)	6.2	16.8	7.6	2.44	(1.30, 4.62)	9.9
Not used community nursing services	50.9	33.9	2.00	(1.45, 2.89)	25.3	63.1	45.2	2.08	(1.41, 3.03)	32.8
House call from GP	6.2	2.3	1.89	(0.90, 3.86)	2.0	4.3	4.2	1.02	(0.39, 2.65)	0.0
Baby clinic for illness	62.2	61.1	0.95	(0.68, 1.33)	-	66.7	62.8	0.84	(0.57, 1.25)	-
Accident and emergency	9.6	5.3	1.92	(1.05, 3.44)	4.6	13.3	8.4	1.67	(0.91, 3.09)	0.1
Hospitalised	9.6	6.9	1.44	(0.80, 2.54)	2.9	17.6	9.7	2.04	(1.16, 3.60)	9.2
Not attended antenatal classes	74.3	50.9	2.79	(1.92, 4.05)	47.7	75.6	65.0	1.67	(1.09, 2.53)	30.3

AR=attributable risk.

risk by the two scores was 0.59 (95% CI 0.50, 0.66) for the cases and 0.59 (95% CI 0.54, 0.65) for the controls.

The infants were divided into a high and a low risk group using a cut off score of 350 on the CID score. The month of death for the cases was not statistically significantly different between the high and low risk groups ($\chi^2 = 7.31$, $df = 11$, $p = 0.77$). Some of the other characteristics of these two groups are shown in table 2. In the low risk group there were statistically significant differences for sex, marital status of the mother, ethnic group, socio-economic status, birth weight, and age at death for the cases compared with the age at interview for the controls. In the high risk groups there were significant differences for sex, birth weight, and gestational age.

The associations between SIDS and the child care practices amenable to modification are shown in table 3. The differences between the controls in the high and low risk groups based upon the CID score were statistically significant ($p < 0.001$) for the prevalence of breast feeding, smoking, and bed sharing but not for sleeping position. Prone sleeping position and maternal smoking were statistically significantly associated with SIDS in both groups, the magnitude of the associations being similar. The prevalence of not breast feeding on discharge from the obstetric hospital among the controls in the high risk group was similar to that among the cases in the low risk group; however, the odds ratios for both the high and low risk group were similar. The association between bed sharing and SIDS seemed to be more pronounced among those at high risk, but again the difference between the odds ratios was not statistically significant. The relative attributable risk (RAR) for the high risk groups, explained by their higher level of exposure to risk factors, compared with the low risk group, were 32.3% for smoking, 8.8% for bed sharing, and 1.0% for breast feeding at discharge from hospital. As the prevalence of prone sleeping position was slightly lower among the high risk group, no excess risk could be attributed to that.

The association between SIDS and the measures of infection, reactivity, severity of illness, sweating, and respiratory symptoms are shown in table 4. When the high and low risk controls were compared there were statistically significant differences for reports of recent infections ($\chi^2 = 15.23$, $df = 2$, $p < 0.001$) and for the severity of illness score ($\chi^2 = 11.38$, $df = 2$, $p = 0.003$), more symptoms of infections, and the more severe illness being more common among those in the high risk group. There were also statistically significant differences for sweating ($\chi^2 = 12.91$, $df = 2$, $p = 0.002$), sweating more often than once a week being more common among those in the high risk group. Respiratory symptoms were also significantly more common among the high risk control group ($\chi^2 = 11.78$, $df = 1$, $p < 0.001$). There were relatively strong associations between the severity of illness measure and the sweating measure and SIDS but the magnitude of the association was similar for both high and low risk groups. The highest RARs in the high risk

group were 16.9 for respiratory symptoms and 7.8% for sweating.

The final selection of measures included those for the use of obstetric, antenatal education, community child health, and medical services. Attending the baby clinic for illness, receiving a house call from the general practitioner, attendance at the accident and emergency department, or admissions to hospital could be considered proxy measures for illness as well as measures of use of services. The use of the Plunket community clinic or child health nursing service, or not having a six week check are measures of the use of the preventative services provided. There were differences between the controls in the high and low risk groups based upon the CID score for the use of services provided at the Plunket clinic or public health nurse ($\chi^2 = 12.35$, $df = 1$, $p < 0.001$). Only 54.8% of the mothers of high risk infants used this compared with 66.1% in the other group. The difference in the use of antenatal care was also significant ($\chi^2 = 18.72$, $df = 1$, $p < 0.001$) – again, mothers whose infants were deemed to be at high risk after birth used it less. The odds ratios for SIDS were similar in the high and low risk groups, suggesting that the level of risk does not modify the association between SIDS and any of these measures of health care utilisation. The RAR of note was 12.5% for not using community services.

Discussion

The results of this study show that risk scores continue to identify those most at risk of SIDS. There also seem to be some differences in how well the risk scores perform in different regions. The level of risk, however, was not an effect modifier for any of the risk factors considered suggesting no unique mechanism or aetiology for SIDS in either group. There were differences between those included in the study and those who were not, but these were unlikely to affect the generalisability of the results.

The purpose of a risk score is to identify those infants most likely to die of SIDS, either for the purposes of future research or for delineating families that will benefit most from additional supportive health services. It has never been suggested that the risk factors from which the score was derived have a causal relationship with SIDS but rather it is argued that if "special" care were given to those at high risk, problems with their nurture may be resolved, thus improving their chance of survival through infancy.^{6,17} The assumption that the provision of special care will prevent deaths was based initially either on anecdote or upon the results of a number of studies based on a series of cases. Such studies, generally based upon infants who have died of SIDS, have suggested that the deaths may be associated with low rates of breast feeding, increased rates of colds and minor infections, or evidence of growth delay.¹⁸⁻²⁰ Some of the measures considered in this study could be regarded as measures or proxy measures for some of these.

A number of attempts have been made to evaluate the effect of interventions among high

risk infants. An intervention study in which high risk infants were randomly assigned to two groups endeavoured to show that more surveillance reduced the expected rate of SIDS. Unfortunately, this study was stopped for perceived ethical reasons, although the differences shown in the results were not statistically significant.⁷ The intervention programme continued, extra surveillance being provided for a large number of high risk infants born in Sheffield between 1973 and 1979, who were scored at birth for risk of unexpected infant death. The form of intervention was continually developing, but included home visiting by health visitors and a campaign to promote breast feeding and to ensure that bottle feeds were made up correctly. The authors concluded that the intervention was successful because the rate of possibly preventable deaths fell from 5.2 per 1000 to 1.9 per 1000. Some of the decline was associated with a rise in the average age of the mother, a fall in the number of pregnancies, a reduction in the number of precipitate deliveries, and an increase in breast feeding. The study occurred at the time of declining post neonatal mortality and changing practices in contraception in the north of England²² making the interpretation of the results difficult. In Nottingham, a risk score was developed which identified 9% of the population as high risk, and in which 53% of the deaths were expected to occur.²² This group of children was followed up more intensively from 1978 onwards by health visitors and general practitioners, who provided advice on the early recognition of respiratory symptoms. Although the post neonatal mortality fell from 6.5 per 1000 live births in 1977 to 5.2 per 1000 in 1983, it was not possible to show that the rate declined more quickly after the introduction of the scoring system. The authors concluded that it was not appropriate to recommend birth scoring systems and that resources should be concentrated on general improvements in services and symptom recognition. Interest in risk scores has continued and it is still argued that if infants at high risk can be identified strategies can be put in place to help prevent their deaths. Those suggested generally consist of advice about child care practices and help in the recognition of illness and the provision of extra surveillance. This assumes that the child care practices of those considered to be high risk differ from those among the remainder of the population, and that the mothers are less likely to recognise illness and make appropriate use of health services.

The results of this study show that using the recommended cut off points, the CID score identified 54.3% of the cases and 18% of the controls, suggesting that its performance overall was very similar in this sample to its performance in the sample from which it was derived.¹¹ There were some differences among the regions; the cut off seemed to identify more cases in some than it did in others. The overall mean for the modified ORLS score of 0.532 was not statistically significantly different from the mean of 0.622 reported in the study based on a large sample of infants born in April

1970.¹⁰ Using the recommended cut off of 2, the ORLS score identified 56.0% of the cases as high risk compared with 18.7% of the controls. The sensitivity and specificity of both these scores were similar to those reported for the ORLS score in a study of infants born in Avon, UK, between 1983 and 1988, in which the sensitivity and specificity were 0.55 and 0.78 respectively.²³ The level of agreement between the CID and the modified ORLS scores in this study was moderate. Because the sensitivity and specificity of the CID score and the modified ORLS score were so similar the groups defined by the CID score were used to examine the effect of other risk factors within these groups. An advantage of the CID score was that it did not include a component for smoking, but did include variables that were consistent with earlier findings of this study.¹² There were also strong associations with infants at high risk and low socioeconomic status and ethnicity of the family.

These results could be used to support the case for different risk scores for different regions, but this argument must be underpinned by evidence that the use of a risk score is worth while in the first place. A statistically significant difference in the association between risk factors and SIDS in the high and low risk groups does not necessarily provide evidence of a different cause of death but may suggest that a different approach could be particularly worth while in one group. It could also be argued that if a substantial amount of the excess attributable risk in the high risk group could be explained by the differences in the prevalence of some risk factors it would be worthwhile considering strategies that could be put in place to overcome these differences. The absence of a significant interaction effect may mean that there is none or that the study has insufficient power to detect such an effect.

The results of this study suggest that the role of the modifiable risk factors is not different between the high and low groups. There are differences between the odds ratios but insufficient evidence to reject the null hypothesis that the odds ratios are the same. The largest differences were for bed sharing, and the different prevalence of this variable results in the population attributable risk being different for the two groups. The odds ratios for prone sleep position and smoking were similar, but again differences in prevalence may lead to different population attributable risks. Apart from maternal smoking, for which the RAR in the high risk group was 32.3%, the RAR that can be attributed to other risk factors was relatively small – 22.3% for bed sharing being the largest. Some individuals may have been identified as high risk because of the link between maternal smoking in pregnancy and low birth weight. As the level of risk did not seem to moderate the effect of any of the modifiable risk factors for SIDS, publicity and education relating to these should be directed towards the community at large. None of the ARs were adjusted for possible confounding factors.

The magnitude of the odds ratios for the high and low risk groups defined by the CID

score were similar for the measures of infection and illness. The higher prevalence of these symptoms of illness among the high risk infants contributed to a higher population AR, although the RAR was relatively small, the highest being 8.8 for sweating. The differences between the controls for these variables suggest that the risk score is not only related to SIDS, but identifies infants with other problems. The risk score identified a group of infants who had higher levels of infection and symptoms of illness requiring attention and more of whom were likely to have drenching sweat more than once a week. Another study has shown that when a group of children was examined at age 5 years, infants who have high scores on the ORLS but did not succumb to cot death were more likely to have a history of pneumonia and may have had a propensity for respiratory infection which the authors suggested may be of importance in the aetiology of SIDS.²³

The odds ratios associated with the use of services were similar for both groups. The use of doctors, hospitals, and clinics for sickness was also similar. High risk groups were less likely to use antenatal care and community child health clinics for preventive health. It is possible that families with infants in the high risk group were recognised as such and that the community health nurse continued to visit them at home. The argument for extra care in the form of supplementary visits from health nurses or alerting general practitioners may be misplaced. This study suggested that, in New Zealand at any rate, both groups used many of the services in a similar way. The similar odds ratio for sweating and the severity of illness in both groups indicated that any initiatives that teach parents to recognise and respond to illness in their children should be universal.

The RAR is a measure of the excess risk that can be attributed to different rates of exposure in the high risk group when compared with the low risk group. The RAR for breast feeding was 3.2%, that for the use of community nursing services 12.5%, and that for respiratory disease 16.9% indicating that the excess risk that can be attributed to these factors was small. There was no RAR for severity of illness. This suggests that intervention programmes for high risk groups which aim to promote breast feeding, provide more home visiting by health nurses, and increase the ability of mothers to recognise illness may not be justified. The RAR for smoking was higher at 32.3%, but as the AR for smoking in the low risk group was 30.6 and in the high risk group 48.6 it seems that smoking was an important risk factor in both the high and the low risk groups. Other studies have explored the issue of whether or not there are different risk factors for different groups. In a study in the United Kingdom it was found that smoking in pregnancy was the best single characteristic for predicting SIDS in the whole sample. While their analyses show that the risk factors for the four groups, based upon the age of death, were different, little was achieved in terms of sensitivity or positive predictive value by using different risk factors for different groups. They argued that smoking both during

and after pregnancy might justifiably be labelled a cause of SIDS.²⁴

The RAR for bed sharing was 22.3%. Another report from the New Zealand study has shown that infant bed sharing is associated with SIDS, particularly among mothers who smoke. As the attributable risk for cases exposed to both factors was about 20% of all SIDS, the authors argued that about one fifth of all sudden infant deaths would be prevented by the removal of either risk factor.²⁵ The prevalence of smoking was high among the high risk group so it seems plausible that at least some of the AR for bed sharing for that group can be attributed to exposure to both factors.

Our results when combined with those of previous research do not provide support for the use of risk scores as a population screening test for SIDS. Before a screening programme can be instituted, it must meet internationally accepted criteria regarding the disease, the screening test, and also the treatment (or intervention).²⁶ While SIDS is clearly a major cause of post neonatal mortality in developed countries, its natural history is poorly understood so that it does not have a long recognisable latent period. The results from our study show that the performance of the risk scores as a screening test is poor, since the positive predictive value is only 6 per 1000 with a SIDS prevalence of 2 per 1000,²⁷ while the low sensitivity (54%) will identify half of all cases for inclusion in any intervention programme. Other studies have reported similarly low predictive values and sensitivities.^{18 22} The low positive predictive value means that nearly all children who screen positive will not develop SIDS, yet they could be vulnerable to the behavioural consequences of being labelled as high risk.²⁷ Lastly, there is no proven intervention that can be offered to high risk children since the limited findings on the effectiveness of improved infant surveillance are inconclusive.

Given the above concerns about the difficulties of using risk scores to identify infants at high risk of SIDS, it seems more appropriate to use population strategies which attempt to lower the mean levels of risk factors in the general population.²⁹ This approach has been successful recently in reducing SIDS by reducing the prevalence of prone sleep position for infants in several countries.^{30 31} The large amount of time, money, and energy required to identify those at high risk, and then provide the extra surveillance judged necessary, may divert resources from more pressing medical needs or be better spent on population strategies to reduce the prevalence of other known risk factors such as maternal smoking.

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The study was funded by the Health Research Council of New Zealand (HRCNZ) and the Hawkes Bay Medical Research Foundation. The authors thank the research interviewees who undertook interviews and the various Plunket Society branches who paid their travelling expenses. Mrs Everard coordinated the study, Mr J Thompson and Mr M Clements organised the data. The authors would also like to thank Alison Stewart for reading the manuscript. Mrs Everard, Mr Thompson, Mr Stewart, and Mrs Williams were funded by the Health Research Council of New Zealand.

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